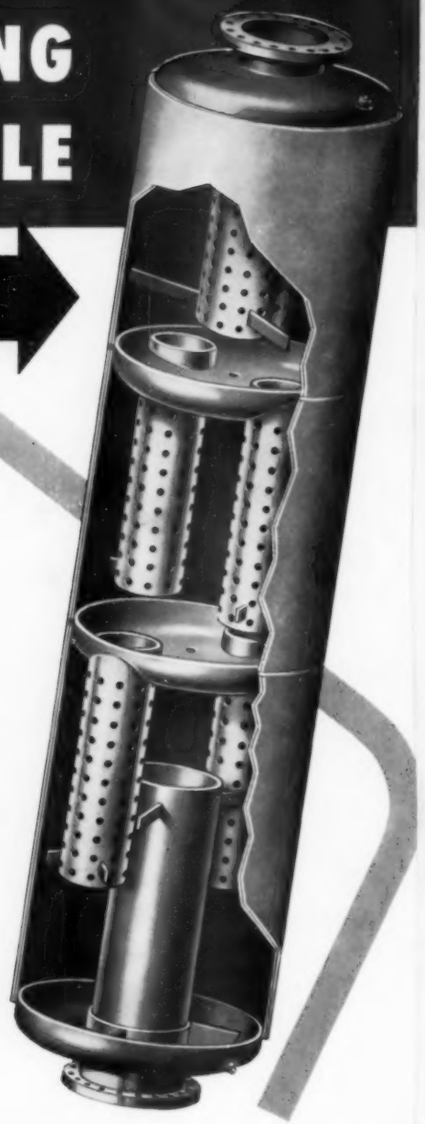
DIESEL ENGINE CATALOG

VOLUME TWENTY-TWO

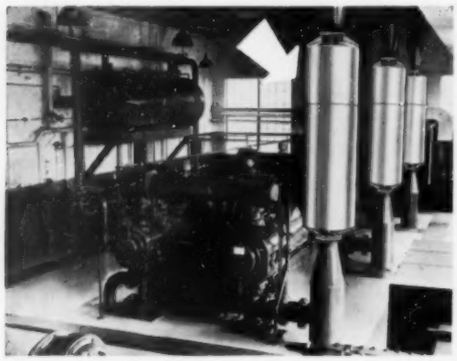
1957-1958

The BURGESS-MANNING SNUBBING PRINCIPLE

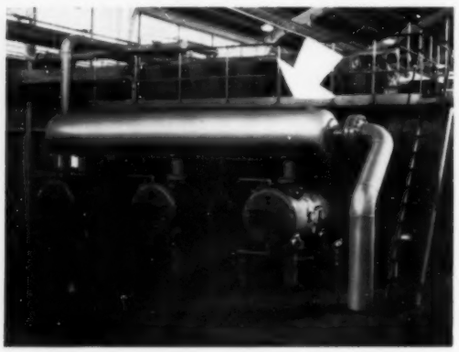
— engineered to your requirements will



STOP — noise from intake or discharge of air, steam or gas to atmosphere, from engines, compressors, vacuum pumps, jets, turbines, etc.

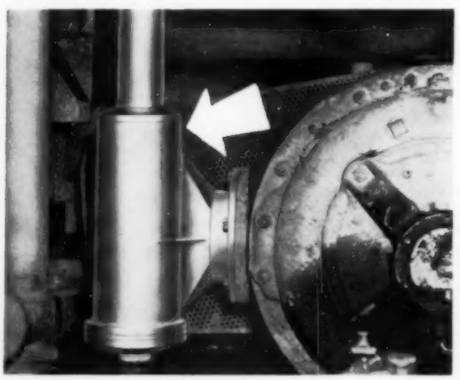


STOP — piping pulsation and vibration from surges created by compressors, pumps, blowers and pressure reduction systems.



STOP — heat waste, thru exhaust, where this may be desired.

STOP — noise and separate all water or similar liquids from gases exhausted from water-sealed vacuum pumps.



STOP — noise and eliminate fire hazard of hot exhaust pipes where engine is operating in close proximity to transfer or storage of high volatiles.

Integrally available are such plus features as: air cleaning and spark arresting.

We offer you a specialized experience and engineering service in noise and surge control. We invite you to present your problems for recommendations.

Sound Engineering

BURGESS-MANNING COMPANY

765 East Park Avenue, Libertyville, Illinois

Dallas, Texas

DIESEL ENGINE CATALOG

REX W. WADMAN — Editor

Printed and published by DIESEL PROGRESS
816 North La Cienega Blvd., Los Angeles 46, California

First printing—May 15, 1957
Printed in the United States of America

Editorial index on next to last page in the book
Advertisers' index on the last page in the book

Additional copies of the DIESEL ENGINE CATALOG may be obtained by remitting $10.00 for each copy desired to the publishers whose address is given above.

VOLUME TWENTY-TWO
1957-1958

DIESEL PROGRESS

HERE'S WHY Advertisers Seeking Sales In The Diesel Market Use DIESEL PROGRESS

Pinpoints the Buyers That Advertisers Want: Leader in the diesel magazine field, DIESEL PROGRESS is deliberately designed to be a selling tool for its advertisers. It pinpoints the buyers *you* want—executives in all major industries who buy and specify new diesel items for original and replacement equipment—management and operating personnel in firms that are expanding, going places. Proof: DIESEL PROGRESS carries 25% more advertising from diesel engine manufacturers than its nearest competition. Its editorial sights are trained on *new* developments as well as common problems, *new* designs as well as engines proven by years in use, *new* applications of existing and projected diesels.

Talks the Buyer's Language: The *readers* of DIESEL PROGRESS respect the *writers* of DIESEL PROGRESS—because they are the same breed of men. DIESEL PROGRESS maintains eight field editors in this country and one in Europe—all of them solidly experienced both in diesels and journalism. Monthly columns are contributed by America's leading diesel experts in the automotive, marine and other fields. The articles in DIESEL PROGRESS are *actual case histories* of diesel applications in use, diesel problems solved, and the latest diesel developments. DIESEL PROGRESS, while its information is detailed and factual, is not a technical journal as such. It is a reporter of diesel news and a meeting place for the exchange of diesel information between experts, the men who know the diesel world. Generous use of photographs and diagrams coupled with brief and incisive text combine to make a wide-open, easy-to-read, format in a big 9 x 12 page size, a format that really *communicates*. Proof: Impartial surveys by a national circulation auditor shows that 91% of the readers of DIESEL PROGRESS consider as useful both editorial *and advertising* content.

NEXT DIESEL ENGINE CATALOG
CLOSES APRIL 1, 1958

Annually for 22 years DIESEL PROGRESS has compiled and published the DIESEL ENGINE CATALOG regarded by the entire diesel industry as the one and only authoritative buying guide and complete reference manual for diesel engines and accessories. This 400-page, 10½" x 13½" size, industry bible is found on every desk that counts in the diesel industry. Hundreds of engines, plus the essential and rapidly advancing fields of turbochargers, transmissions, fuel injection systems, governors—all are presented in their own sections complete with photographs, power curves, specification tables, dimensional installation plans and sectional views, plus full description in the text of products, applications and conversions. In addition, approximately 100 pages of advertising from industry leaders constitute a catalog in themselves!

Do You Know Your Diesel Market?

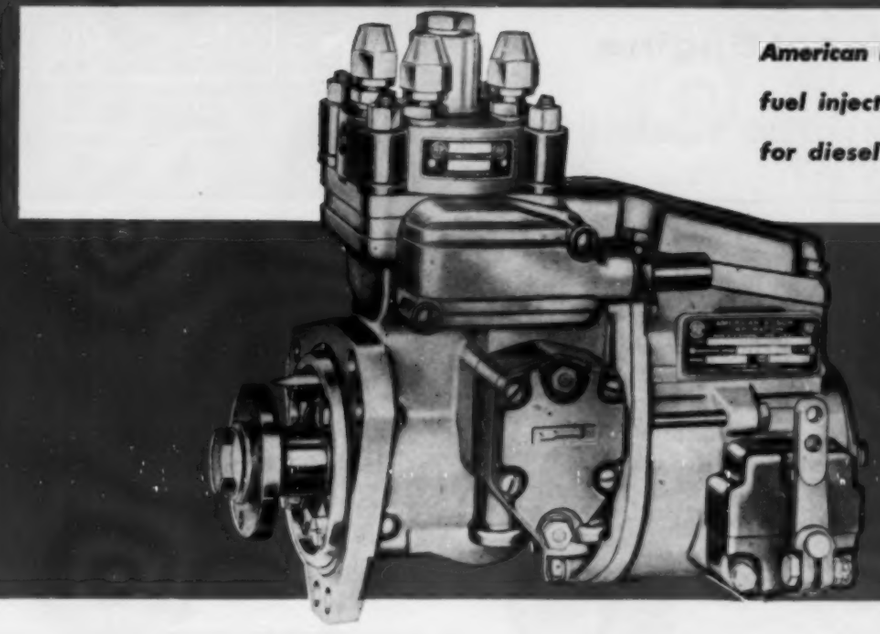
There will be 226,150 diesel, dual fuel and gas engines produced in 1957. Diesels in use today: 2,190,000 engines, 8.3 billion gallons of diesel fuel and 465 million gallons of lubricating oil were used in 1957—a total dollar volume of $1.7 billion.

(For more information write for complete Diesel Progress Market Data File.)

DIESEL PROGRESS

816 N. La Cienega Blvd. Los Angeles 46, Calif.
Phone: OLeander 5-7410

Write today for advertising rates and specifications, or see Standard Rate & Data.



American Bosch PSB fuel injection pump for diesel engines.

Unmatched for service and performance...

That's the record of more than 140,000 American Bosch PSB fuel injection pumps now in service —some for as long as five years. The PSB has many features—simple rugged construction, fewer parts, accurate fuel metering and distribution, positive governor control. Easily replaceable hydraulic head permits quick field servicing. All combine to assure top engine performance and economy of operation, long trouble-free life and *low* maintenance expense.

Every American Bosch fuel injection product is backed by an established and growing system of authorized service agencies, fully equipped and staffed with trained personnel to provide quick, efficient repair service.

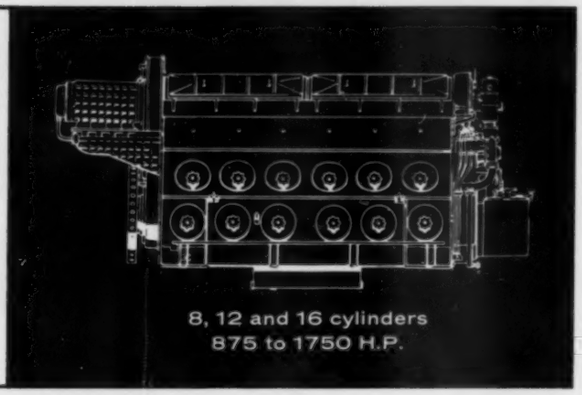
AMERICAN BOSCH

Division of
American Bosch Arma Corporation
Springfield 7, Mass., U. S. A.

4096-B

GENERAL MOTORS
567C
2-Cycle Diesel Engine

Unmatched dependability



. . . for locomotives

Through Electro-Motive's long standing policy of making component improvements applicable to earlier models, railroads today are realizing the second step in obtaining maximum economy from dieselization—remanufacture of older Diesel units. Work-weary locomotives ready for major overhaul can be remanufactured and upgraded with the 567C engine to today's standards—at much less cost than a new unit.

. . . for oil well drilling

The 8-cylinder 567C engine is prime mover in the Electro-Motive Diesel-Electric Power unit for use on both land and offshore drilling rigs. This power plant—most widely used Diesel-electric system in offshore drilling—offers the petroleum industry a new concept in flexibility, control and lower cost drilling power.

. . . for power generation

Electro-Mobile Power units provide electric utilities with a flexible, economical tool for boosting, peak skimming and emergency use. Built in rail units of 1000 kw; truck units of 500 kw; and skid units of 1000, 750 and 500 kw. This new concept of power generation not only serves immediate needs, but is a big factor in helping utilities meet many unusual problems resulting from today's enormous demand for power.

Inquiries are invited from engineers interested in any of the above applications

ELECTRO-MOTIVE DIVISION · GENERAL MOTORS

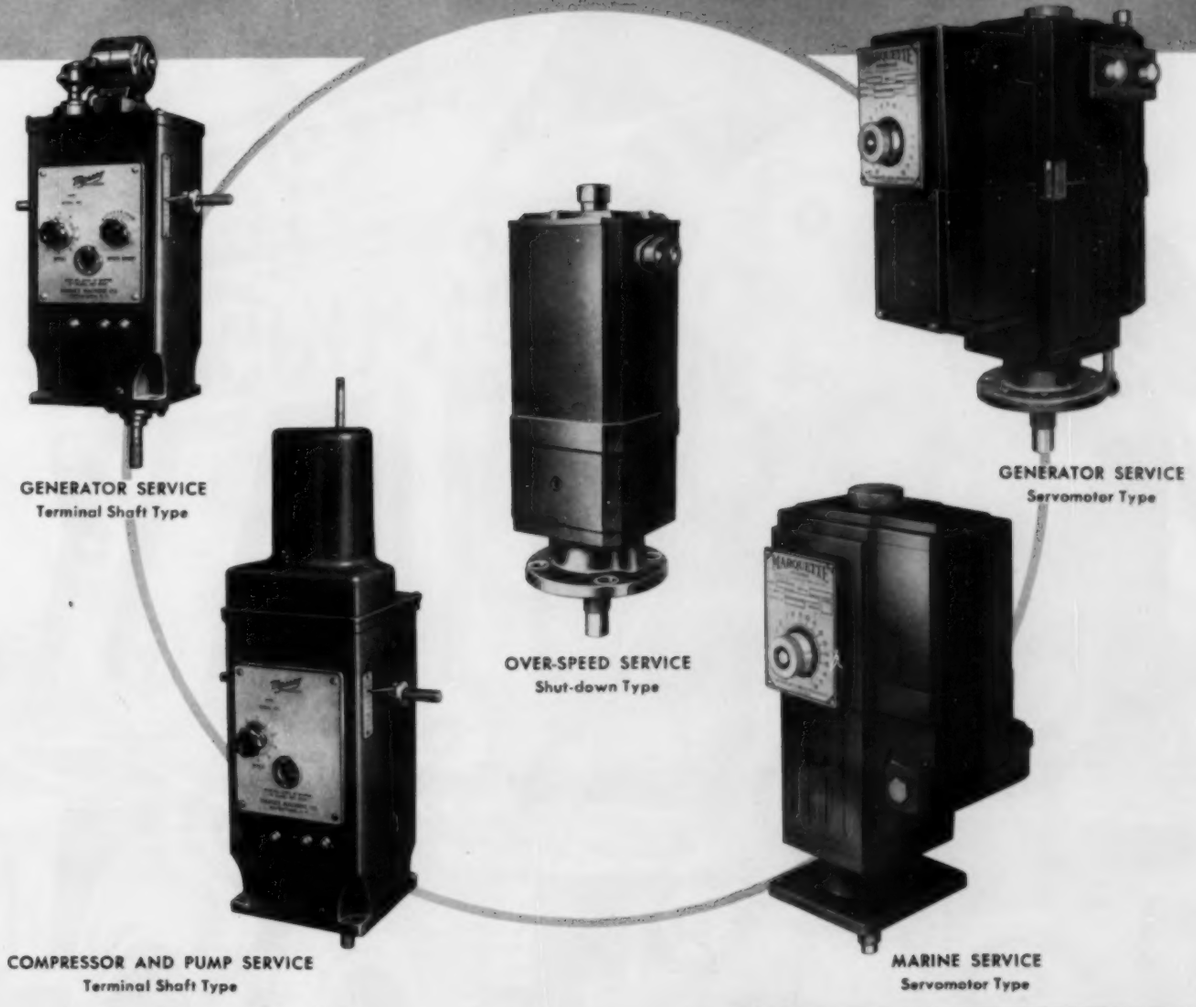
LA GRANGE, ILLINOIS • Sales Offices in Chicago, New York, St. Louis, San Francisco.

Petroleum industry sales offices in Dallas and Houston, Texas; Morgan City, Louisiana; Los Angeles, California.

Massey GOVERNORS

Marquette GOVERNORS

HYDRAULIC ISOCHRONOUS GOVERNORS FOR ALL APPLICATIONS OF ENGINE CONTROL



GENERATOR SERVICE
Terminal Shaft Type

GENERATOR SERVICE
Servomotor Type

OVER-SPEED SERVICE
Shut-down Type

COMPRESSOR AND PUMP SERVICE
Terminal Shaft Type

MARINE SERVICE
Servomotor Type

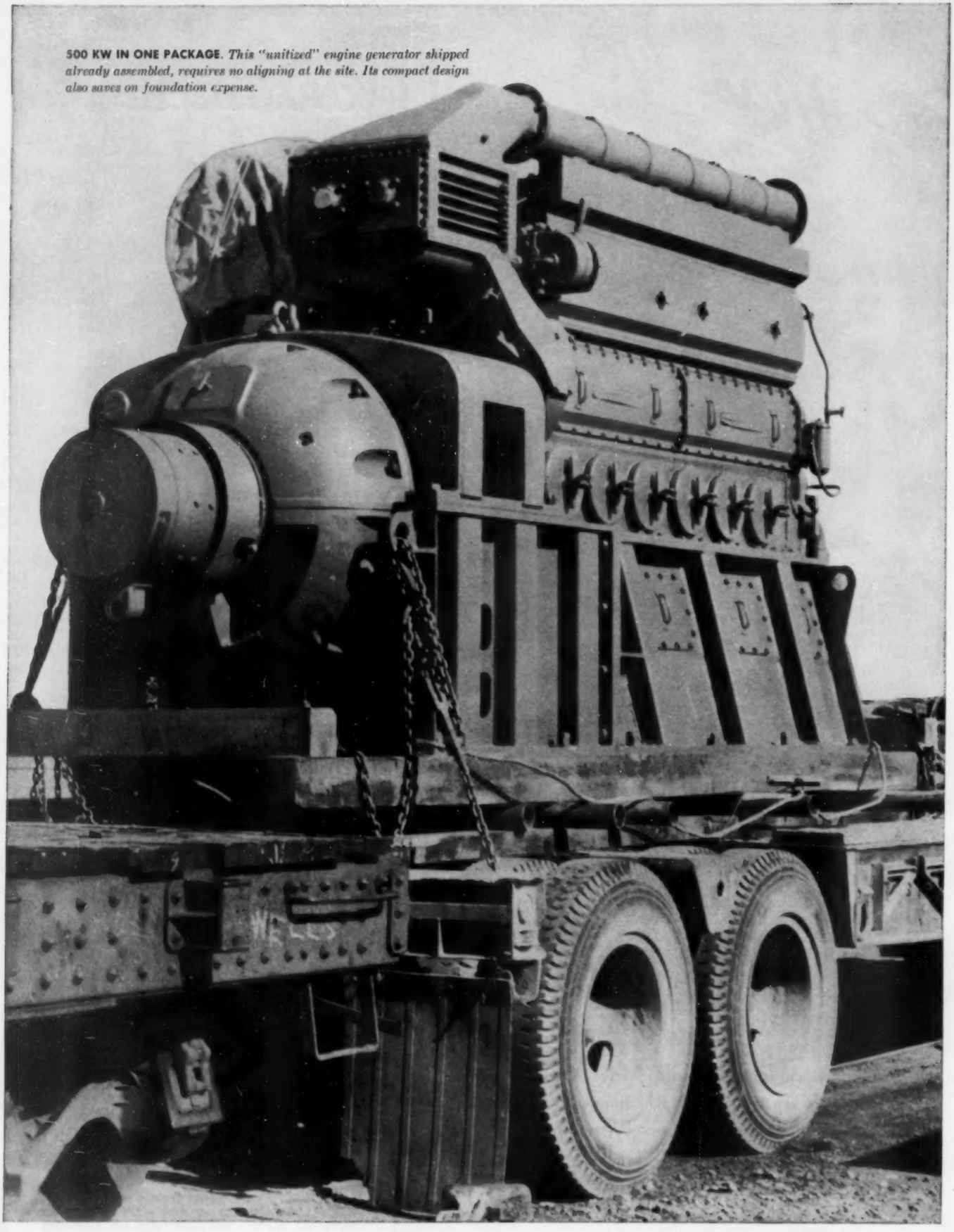
District Representatives and Service Agencies of both companies are available to all customers. Our combined engineering facilities are at your disposal for all problems of governing and control.

MARQUETTE METAL PRODUCTS DIVISION
1145 GALEWOOD DRIVE • CLEVELAND 10, OHIO

MASSEY MACHINE COMPANY DIVISION
785 PEARL STREET • WATERTOWN, N. Y.

MARQUETTE METAL PRODUCTS DIVISION
CURTISS-WRIGHT
CORPORATION • CLEVELAND 10, OHIO

Other Marquette Products: ROLLER BEARING TEXTILE SPINDLES
WINDSHIELD WIPERS FOR AIRCRAFT • SPRING CLUTCHES
ROTARY OIL PUMPS • PRECISION PARTS AND ASSEMBLIES



500 KW IN ONE PACKAGE. *This "unitized" engine generator shipped already assembled, requires no aligning at the site. Its compact design also saves on foundation expense.*

1957 POWER!

Long famed for reliability, Worthington 1957 power engines have many new features that can help you produce permanent or standby power at the lowest costs ever achieved for real *heavy-duty* units.

LOWER INSTALLATION COSTS—The new SW 9 engine you see at left has been "unitized" with its generator to drastically cut space requirements, installation time and expense. This design requires no aligning at the site. Should needs ever change, the entire unit can just as easily be picked up and moved to another location.

LOWER FUEL COSTS—In 1957, Worthington is pioneering in power by designing and building engines *specifically* for turbo-charged operation. The SW 14, for example, is America's first high output diesel built only for high pressure turbo-charging.

For economy today *and* tomorrow, all '57 Worthington power engines can be furnished to run on the lowest cost, locally available fuels—residual, crude, and distillate oils; natural, sewage, propane or manufactured gas.

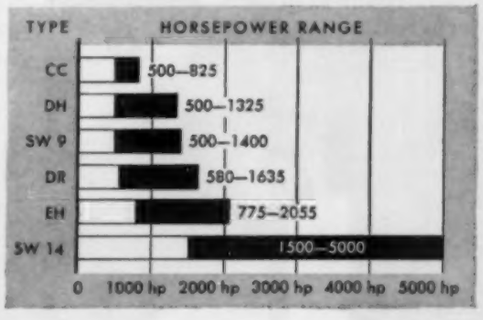
LOWER MAINTENANCE COSTS—With Worthington's 1957 engine line, you enjoy the economy of modern power design plus amazingly low maintenance. One of the many maintenance-saving features of the new SW 9, for example, is the Jet Swirl combustion chamber. The chamber is designed so that the air swirls as it enters the cylinder assuring rapid mixing of air and fuel for extremely clean combustion giving longer valve and liner life, as well as ultra-efficient operation.

The fact that every upper mechanical part is within reach from the operating level is another maintenance saving feature.

For reliable power in the 500 to 5,000 hp range, at the lowest possible cost, get in touch with your nearest Worthington District Office. Worthington Corporation, Harrison, N. J. In Canada: Worthington (Canada) 1955, Ltd., Toronto, Ont.

E-7-1

Choose your next diesel from Worthington's complete line of heavy-duty four-cycle power engines.



WORTHINGTON

WOODWARD

HYDRAULIC GOVERNORS

FOR ALL INTERNAL COMBUSTION ENGINE APPLICATIONS

WOODWARD GOVERNOR COMPANY

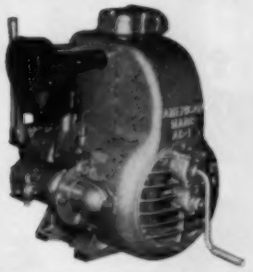
ROCKFORD, ILLINOIS

Fort Collins, Colorado — Schiphol, The Netherlands

WORLD'S OLDEST AND LARGEST MANUFACTURER OF HYDRAULIC GOVERNORS EXCLUSIVELY

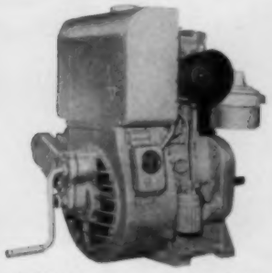
AMERICA'S LARGEST MANUFACTURER OF AIR-COOLED DIESELS PRESENTS

THE BIG 4 IN DIESEL POWER

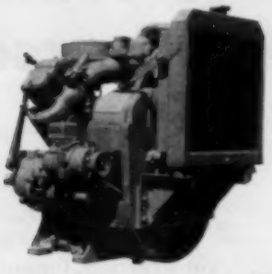


AC1: Air-cooled, one-cylinder, 4-cycle, 6.5 BHP @ 1800 RPM

AC2: Air-cooled, two-cylinder, 4-cycle v-type, 14 BHP @ 1800 RPM



WC1: Water-cooled, one-cylinder, 4-cycle, 7 BHP @ 1800 RPM



WC2: Water-cooled, two-cylinder, v-type, 4-cycle, 15 BHP @ 1800 RPM

AMERICAN MARC'S COMPLETE UNITS

Complete units for many purposes are also manufactured by American MARC — Diesel generating plants from 3 to 10 KW (AC or DC, and industrial three-phase), Diesel pumping units from 4 to 1700 GPM, marine propulsion, refrigeration units and power-packages for other services. American MARC can adapt any of its Big 4 engines to fit every job requiring from 6.5 to 20 BHP.

AMERICAN MARC Inc. dominates the field of lightweight, low-horsepower Diesels by building its diversified line from the "Big Four" basic models illustrated here. Purchase and maintenance of engines and parts are simplified by the use of these compact and rugged prime movers. All four are employed daily by thousands of satisfied American MARC customers in the fields of industry, agriculture, home or marine use.

SOME DESIRABLE SALES TERRITORIES ARE STILL OPEN. INQUIRIES ARE INVITED FROM REPRESENTATIVE DEALERS.

A1Q Generating Plant:
3KW generator quill-mounted to American MARC air-cooled Model AC1. This and the Model A2Q Generator (5 KW) are ideal all-weather outfits for small home and farm requirements.

AMERICAN MARC INC.

1601 West Florence Avenue — Inglewood, California

ENGINES OF QUALITY

For details and specifications on all American MARC engines, see our story in the editorial section.

Specify FULLER Transmissions . . . to deliver diesel horsepower, *efficiently!*

For on- or off-highway operation, under all conditions of time, traffic and terrain, get *full* value from your diesel engines through Fuller Transmissions.

In big rigs on the highway . . . and in construction, logging, mining, petroleum equipment . . . you specify the make of vehicle, the type, and the engine. Specify the transmission too — from a wide variety of Fuller models designed for diesel application. Ranges from 100 to 400 hp cover every heavy-duty condition on or off the highway.

Fuller Transmissions are designed to operate quietly, efficiently, dependably, profitably . . . to stand up under rugged operating conditions. Check with your truck or equipment dealer for the *right* Fuller Transmission for *your* job.

Get complete details now.

Fuller TRANSMISSIONS

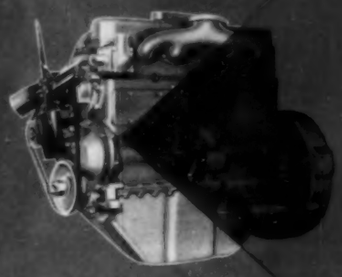
really
where horsepower goes to work

FULLER MANUFACTURING CO., KALAMAZOO, MICH.

Unit Drop Forge Div., Milwaukee 1, Wis. • Shuler Axle Co., Louisville, Ky. (Subsidiary) • Sales & Service, All Products, West. Dist. Branch, Oakland 6, Cal. and Southwest Dist. Office, Tulsa 3, Okla.

HERCULES DIESEL

The complete line of Hercules Diesels provides dependable power from 12 to 500 H.P. Over 44 models are manufactured in 1, 2, 4, 6 and 8-cylinder sizes. Two different types of combustion systems are available — the high-speed, heavy-duty turbulence chamber type and the new direct-injection type. The application of Hercules Diesels is flexible, in that these engines may be adapted and installed in many different types of equipment. In addition to the standard models of engines listed below, Hercules Diesels are manufactured as open, closed and base-type power units.



D. D. 6 Cyl. Diesel

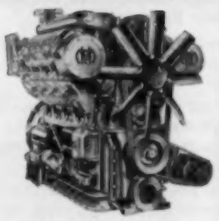
Interchangeable

The new D.D. Series (Direct-injection Diesels) are interchangeable with the new Hercules G.O. Series (Gasoline Overhead-valve). Mounting dimensions of the G.O. and D.D. series of like cylinders are exactly the same. Many component parts are also interchangeable.

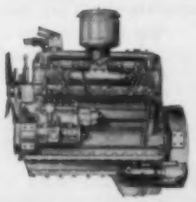
For more details on these new engines or any of the Hercules Diesels — write the factory. We will be happy to assist you in solving your power problems.

G. O. 6 Cyl. Gasoline

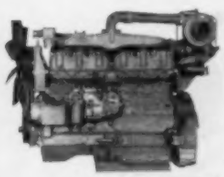
6 Cyl. Diesel Power Unit



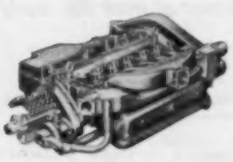
Vee type 8 Cyl. Diesel



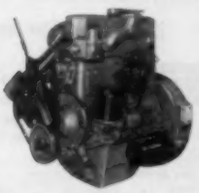
6 Cyl. Turbulence Chamber Diesel



6 Cyl. Turbo-charged Diesel



"Pancake" or Horizontal Diesel

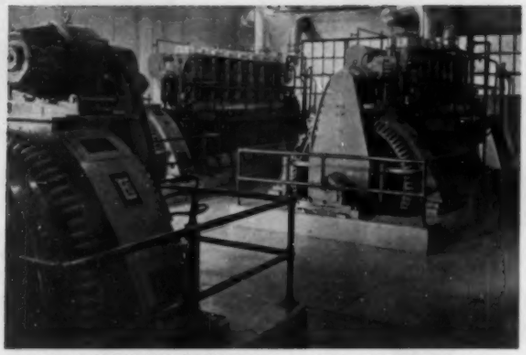


4 Cyl. Direct-injection Diesel

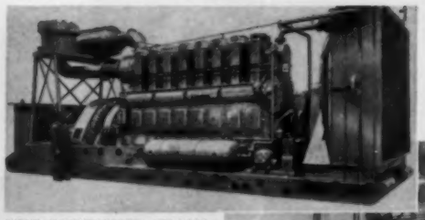
HERCULES DIESELS

NO. OF CYLS.	MODEL	BORE AND STROKE	CU. IN. DISPL.	NO. OF CYLS.	MODEL	BORE AND STROKE	CU. IN. DISPL.
1	DIX-42	3⅝"x4"	42	6	DJXH	3⅝"x4½"	298.2
2	DIX-83	3⅝"x4"	83	6	DJXH-F	3⅝"x4½"	298.2
2	DIXC	4" x4½"	113.1	6	DD-329	4" x4½"	339
2	DIXD	4½"x4½"	127.5	6	DWXC	4" x4¾"	338
3	DD-130	3½"x4½"	130	6	DWXD	4¼"x4¾"	404
3	DD-149	3¾"x4½"	149	6	DWXLD	4¼"x5"	426
3	DD-169	4" x4½"	169	6	DWXLD-F	4¼"x5"	426
4	DIX4B	3¼"x4"	133	6	DRXB	4⅜"x5⅛"	474
4	DIX4D	3½"x4"	166	6	DRX-501	4½"x5⅛"	501
4	DD-173	3½"x4½"	173.2	6	TCD-501	4½"x5⅛"	501
4	DOOB	3¾"x4½"	198.8	6	DRXC	4⅝"x5⅛"	529
4	DD-198	3¾"x4½"	198.8	6	DFXB	5" x6"	707
4	DOOC	4" x4½"	226.2	6	DFXC	5⅛"x6"	779
4	DD-226	4" x4½"	226.2	6	DFXD	5½"x6"	855
4	DOOD	4¼"x4½"	255	6	DFXE	5⅝"x6"	893
6	DIX6D	3¾"x4"	248	6	TCD-895	5⅝"x6"	895
6	DD-260	3½"x4½"	260	6	DFXH	5⅝"x6"	935
6	DJXB	3½"x4½"	260	6	DFXH-TS	5⅝"x6"	935
6	DIX6-272	3 11/16"x4¼"	272	6	DFXH-F	5⅝"x6"	935
6	DJXC	3¾"x4½"	298.2	8	DNXVBD	6¼"x6"	1468
6	DD-298	3¾"x4½"	298.2	8	TCD-1468	6¼"x6"	1468

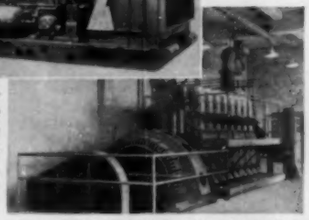
HERCULES MOTORS CORPORATION Canton 2, Ohio



LOW COST MUNICIPAL POWER. Three Enterprise DSG-38 Turbocharged Diesel Generator Sets resulted in $38,000 annual profit for the City of McLeansboro, Ill. Electric rates were cut, plant is quickly paying for itself.

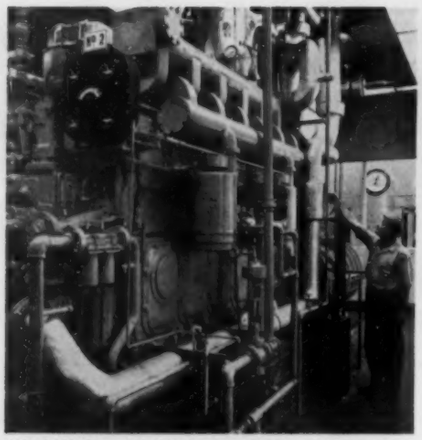


SELF-CONTAINED TRANSPORTABLE POWER, fully equipped for immediate field operation, gets big jobs done faster, for less. This Enterprise unit is specially designed for use in remote areas.

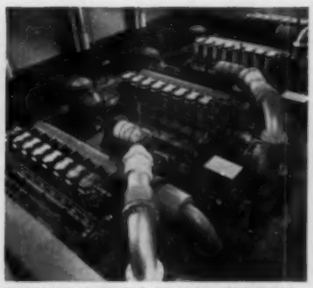


AUTOMATIC STANDBY ELECTRIC POWER. There will be no blackouts at San Francisco's new $50,000,000 International Airport with this 1000 KW Enterprise fully automatic standby unit.

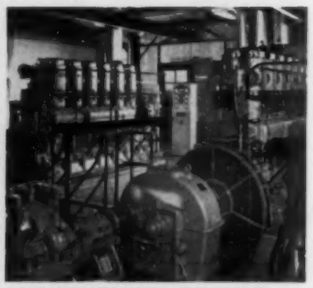
The Switch is to ENTERPRISE —the pay-off is in more efficient, lower-cost power



BIG SAVINGS IN SEWAGE DISPOSAL. Six Enterprise Spark Ignited Gas Engines, burning sewage sludge gas, replaced purchased power for pumping 40 million gallons of sewage daily through San Diego plant.



INSTANT ACTION WATER PUMPING. Oakland, California licked a storm flood problem by installing four 1200 HP Enterprise Engines. They drive huge mixed-flow pumps, are fully automatic.



PEAK EFFICIENCY FOR PIPELINE PUMPING. Union Oil Company's Ventura Station, powered by two Enterprise 465 HP Engines, is capable of handling fluctuating loads regardless of viscosity changes.

BASIC ENGINE DATA				
ENGINE MODEL	BORE & STROKE	NUMBER OF CYLINDERS	HP	RPM
M	8 x 10	3, 4, 6 & 8	73-1015	450-1000
G	12 x 15	6 & 8	273-2313	250-750
Q	16 x 20	6 & 8	647-2924	250-400
R	17 x 21	6 & 8	767-3467	250-400
RV	17 x 21	12 & 16	1228-7703	200-400

Our product is power—low cost, dependable power designed and proved for the tough, demanding municipal and industrial jobs.

Here are some of the things that officials, owners, operators and superintendents say about their Enterprise power:

"Our Enterprise has averaged 14,000 BHP hours per gallon of lube oil!"

"After switching to Enterprise, estimated savings in fuel alone will amount to $12,000 per year."

"Our operating costs were cut $3,000 per month when we switched to Enterprise Dual-Fuel operation."

"Our Enterprise units were a deciding factor in bringing new industry to settle here."

When you talk to the satisfied Enterprise customers in your area, you'll see why your next engine should be an Enterprise, too. Then call your nearest Enterprise sales office, or write us direct for prompt information and recommendations on your problem.

Over a million horsepower at work the world over!

ENTERPRISE *dependable* **ENGINES**

ENTERPRISE ENGINE & MACHINERY CO.
Subsidiary of General Metals Corporation
18th and Florida Streets, San Francisco 10, California
Export Department, San Francisco

Boston • Chicago • Des Moines • Fort Worth • Huntington • Jacksonville • Kansas City • Los Angeles
New Orleans • New York • Pittsburgh • San Diego • Seattle • St. Louis • Washington, D.C.

ENGINEER'S FIELD REPORT

PRODUCT RPM DELO OIL

EDWARD KEEBLE CONSTRUCTION CO.
FIRM San Jose, California

RPM DELO Oil keeps tractor on the job 15 years

Still Working after 15 years using RPM DELO Oil in this D-8 Caterpillar operated by Edward Keeble Construction Co. Block, crankshaft, and most other parts of original engine are still in use. Another of firm's D-8's using RPM DELO Oil ran 12,000 hours without engine repairs. When torn down, maximum crankshaft wear was .004".

Crawler Crane, like firm's other heavy-duty equipment, uses RPM DELO Oil. Keeble operates 120 pieces of construction equipment—has as many as 30 jobs going at once.

GMC V-8 10-Yard Dump Truck (left), one of a new fleet of 12, also uses RPM DELO Oil. Mr. Keeble (right), says, "For the past 15 years we have kept our heavy-duty engines in top operating condition with RPM DELO Oil. In several instances engines have actually outlasted equipment."

Why RPM DELO Oils reduce wear—prolong engine life

- Oil stays on engine parts – hot or cold, running or idle
- Anti-oxidant resists lacquer formation
- Detergent keeps parts clean
- Special compounds prevent corrosion of bearing metals
- Inhibitor resists crankcase foaming

For More Information or field help with any fuel or lubrication problem, contact representative of any company listed, or write direct.

LUBRICATING OILS RPM DELO

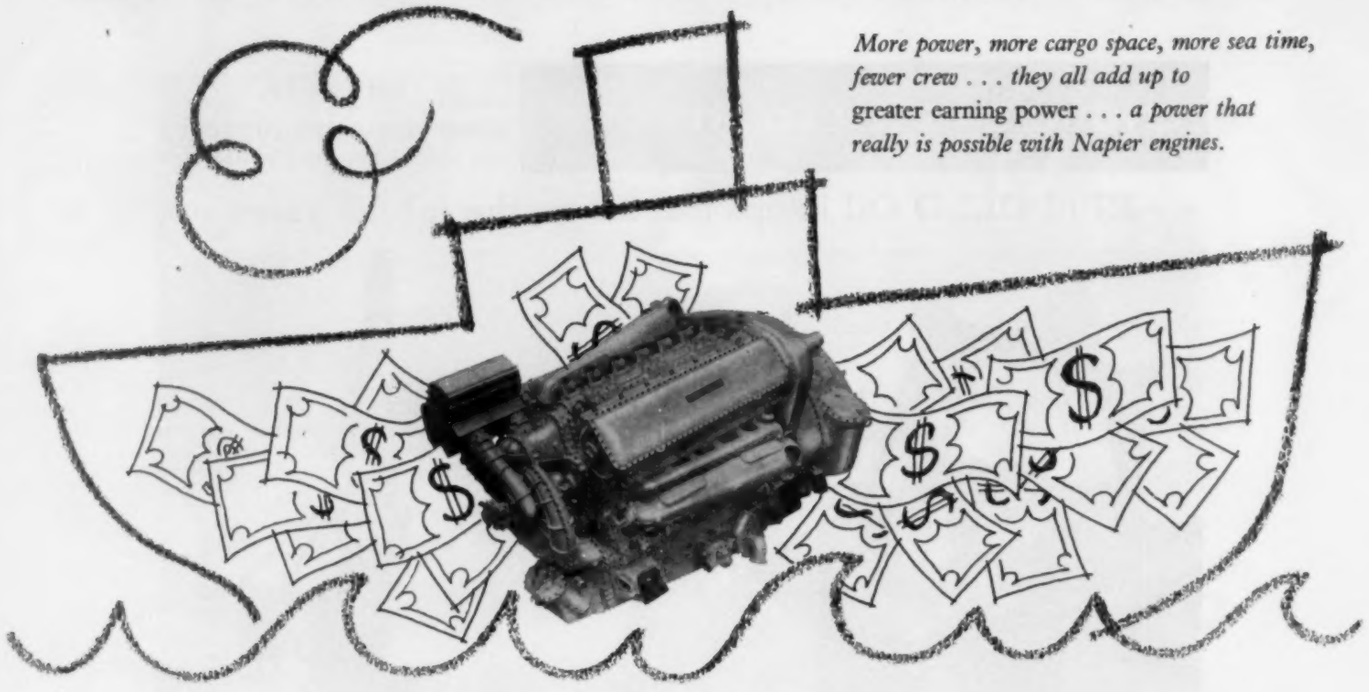
TRADEMARK "RPM DELO" AND DESIGN REG. U. S. PAT. OFF.

STANDARD OIL COMPANY OF CALIFORNIA, 225 Bush Street • San Francisco 20, California

THE CALIFORNIA COMPANY, P. O. Box 780 • Denver 1, Colorado

STANDARD OIL COMPANY OF TEXAS P. O. Box 862 • El Paso, Texas

NAPIER GIVES A SHIP NEW EARNING POWER!



More power, more cargo space, more sea time, fewer crew . . . they all add up to greater earning power . . . *a power that really is possible with Napier engines.*

THE DELTIC — WHICH GIVES YOU . . .

1 More speed (Deltic-powered vessels make more voyages per year).

2 More power (the best power/weight ratio of any Diesel engine in the world).

3 Direct engine control from the bridge (less engine crew needed).

4 Easier overhaul (engine is removed for overhaul and changeover can be made in under 8 hours).

5 A smaller engine room (for every unit of b.h.p. the Deltic has one quarter the bulk of a conventional Diesel).

TURBO BLOWERS — WHICH GIVE YOU . . .

1 Lower specific fuel consumption.

2 A big increase in power output (as much as double on 4-stroke diesels and over 30% on 2-strokes).

3 A range of seven sizes for engines of 140 h.p.-4,000 h.p. (multiple installations for higher powers).

4 A life as long as the engine itself.

5 An investment in the highest standards of workmanship.

NAPIER

Partners in Progress with The ENGLISH ELECTRIC Company Ltd.

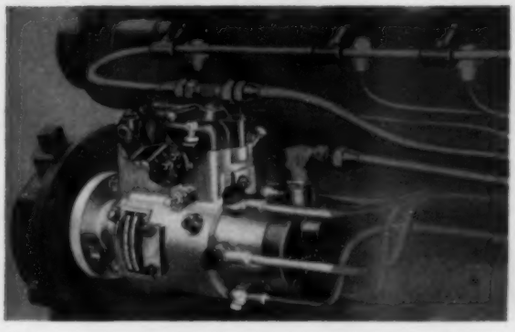
D. NAPIER AND SON LIMITED · LONDON, W.3 · ENGLAND

CEC 327

SIMPLIFIED

fuel injection at its very best

ROOSA MASTER MODEL "D" PUMP



Again Roosa-Master makes a revolutionary contribution to better and simplified diesel fuel injection. The new Model D is lighter . . . smaller . . . more compact . . . yet retains the pace-setting simplified method of fuel injection pioneered by Roosa Master Model A. Designed for use with all major types of high speed engines, Model D offers both the diesel engine manufacturer and user outstanding performance, exceptional dependability and low maintenance costs through easier servicing. Write today for literature and complete information on the modern fuel injection pump that **makes good diesels better.**

You can depend on the diesel that depends on HMS ROOSA MASTER

HARTFORD MACHINE SCREW COMPANY DIVISION OF STANDARD SCREW COMPANY HARTFORD, CONN.

Get reliable mechanical power transmission from WESTERN GEAR "Custom Engineered" gear drives

marine

Sea-Master marine gears are easily installed, reliable and long-lived with bonus features not found in other gears. The full line of Sea-Master reduction gears to 50,000 HP will provide you with an installation tailored to exact propeller speed requirements in vertical offset, horizontal offset, multiple pinion and other standard types to suit the largest medium speed diesel commercial or pleasurecraft application.

The Sea-Master hydraulic reverse and reduction gear line, from 200 to 1,200 HP, is equipped with new Western Gear Flex-Master coupling that "tunes" the propulsion system to vibration-free perfection.

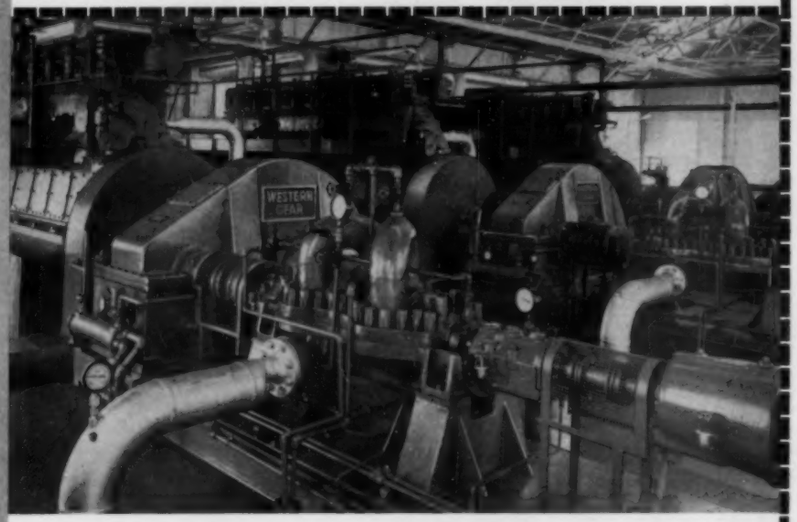
Why not take advantage of the plus services offered by Western Gear custom-engineering?

New tug, M/V Neptune built by Gunderson Bros. for Puget Sound Tug & Barge Co., 106′ x 28′ x 13′, equipped with Sea-Master reduction gears.

stationary

Western Gear speed reducers, increasers and Torq-Master transmissions are custom engineered for perfect installations in stationary and mobile power transmission requirements.

We offer (1) Extensive catalog line of high speed parallel shaft units to 10,000 HP for driving generators, pumps, compressors, fans or similar service. (2) Full catalog line of commercial parallel and right angle speed reducers in all shaft arrangements and horsepower ranges. (3) A wide variety of pneumatic and mechanically shifted transmissions to 600 HP designed for use with commercially available hydraulic torque converters for applications on hoists, rotary table drives, locomotive cranes, logging yarders and similar installations.



Three Model 300HS100 Western Gear high speed units driven by Cooper-Bessemer natural gas engines rated at 675 HP at 450 RPM were selected to drive the United Centrifugal pumps at 3,400 RPM, pumping 1,000 GPM at the Warren Petroleum Corporation processing plant in Antioch, Oklahoma.

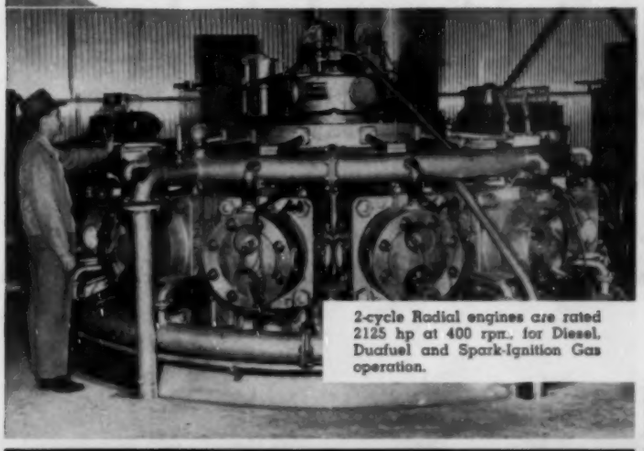
"The difference is reliability" • Since 1888

WESTERN GEAR Corporation
ENGINEERS AND MANUFACTURERS

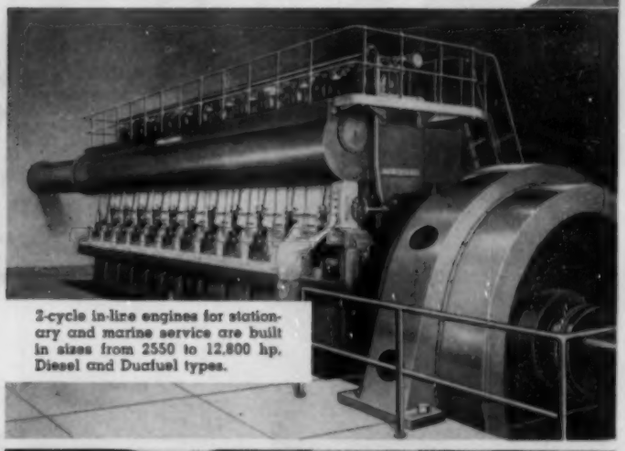
For further details, see editorial section on Western Gear products or write: General Offices, Western Gear, P.O. Box 182, Lynwood, California

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.) SEATTLE AND HOUSTON—REPRESENTATIVES IN PRINCIPAL CITIES

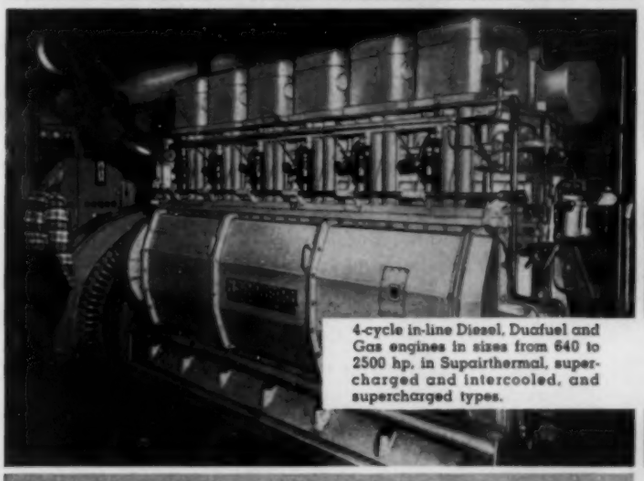
NORDBERG Engines and Experience can solve your power problems . . .



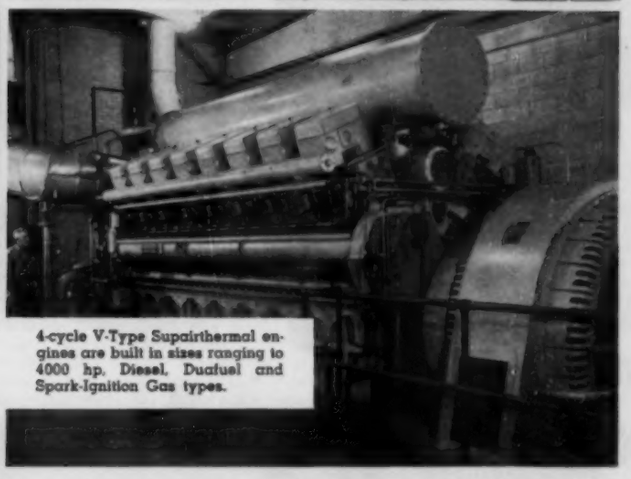
2-cycle Radial engines are rated 2125 hp at 400 rpm., for Diesel, Duafuel and Spark-Ignition Gas operation.



2-cycle in-line engines for stationary and marine service are built in sizes from 2550 to 12,800 hp. Diesel and Duafuel types.

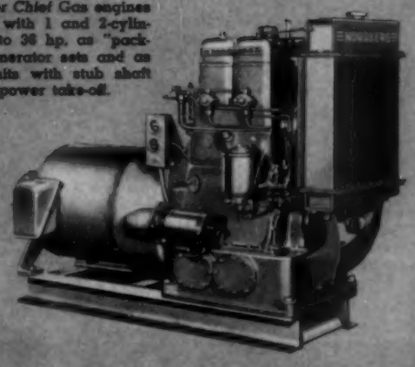


4-cycle in-line Diesel, Duafuel and Gas engines in sizes from 640 to 2500 hp, in Supairthermal, supercharged and intercooled, and supercharged types.



4-cycle V-Type Supairthermal engines are built in sizes ranging to 4000 hp. Diesel, Duafuel and Spark-Ignition Gas types.

Power Chief® Diesels are offered with 1, 2 and 3-cylinders, rated 10 to 45 hp or 6 to 30 kw. *Power Chief* Gas engines are built with 1 and 2-cylinders, up to 30 hp, as "packaged" generator sets and as power units with stub shaft of clutch power take-off.



• Pioneer in the Diesel and Gas engine industry, Nordberg has contributed many of the most notable advancements in the development of more efficient prime movers . . . all in the interest of improved fuel economy, simplicity of design, less maintenance and better overall performance. As a result of this experience, Nordberg today . . . with a full range of engine sizes, from 10 to over 12,000 hp, including Diesel, Duafuel® and Spark-Ignition Gas types, is in the best position to help solve your stationary and marine power problems.

NORDBERG MFG. CO., Milwaukee, Wis.

NORDBERG

DIESEL • DUAFUEL® AND SPARK-IGNITION GAS ENGINES

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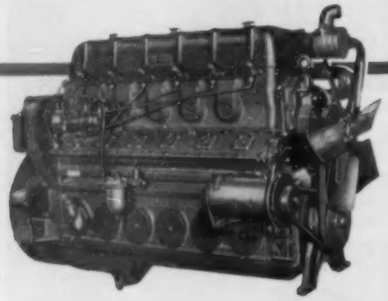
Brilliant Performance Big Weight Saving

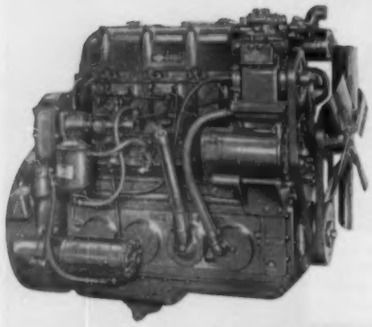
Small Parts Inventory Less Repair Time

P&H DIESELS

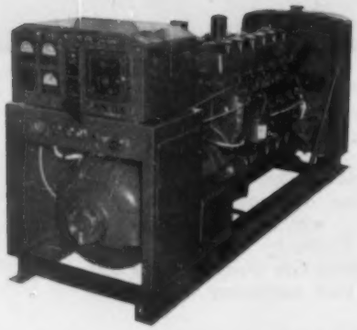
2-CYCLE MODELS—40 TO 280 H. P.



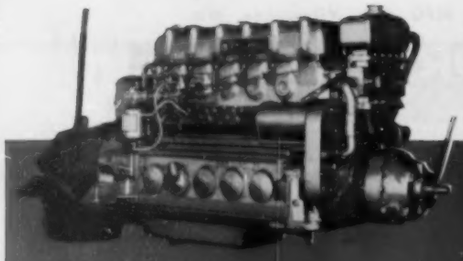
P & H Industrial Diesel. 2, 3, 4 and 6 cylinder models for all industrial and construction applications. 40 to 280 H.P.



P & H Automotive Diesel. 3, 4 and 6 cylinder models for powering trucks from 35,000 lbs. G. C. W. and up. 144 to 280 H. P.



P & H Diesel Electric Generators. Sets for all services. Lighter weight, smaller size. Choice of controls. Models to 125 KW—AC or DC.



P & H Marine Diesel. 2, 3, 4 and 6 cylinder models for main propulsion and auxiliary power.

Improved Series C-18 P&H Diesels are setting new records in construction, automotive, industrial and marine applications by getting more work done, faster, and at a lower cost. Here are some of the reasons.

HIGHLY RESPONSIVE P&H Diesels Series C-18 accelerate and decelerate as fast, idle as well over protracted periods and start in normal temperatures as quickly as a gasoline engine.

HIGHLY EFFICIENT P&H Diesels of modern, lightweight, aluminum design deliver far more horsepower per pound of weight than the average Diesel. Higher torque, too. Also, they burn fewer gallons of low-cost No. 2 fuel oil.

SIMPLIFIED DESIGN of P&H Diesels with 25% fewer parts and interchangeability of wearing parts among all models reduces your parts inventory and cuts repair costs. The "unitized" P&H cylinder head and complete liner assembly, a P&H *exclusive,* is replaceable in only 30 minutes . . . without dropping the oil pan.

For money making and money saving power you can't beat a P&H Diesel. It will pay you to get all of the facts.

For Modern Engineering, Look to

HARNISCHFEGER

P&H DIESEL ENGINE DIVISION
Crystal Lake, Illinois

P&H Diesel Engines The Right Power for your Jobs—
Automotive (on and off highway), Road and Construction Machinery, Oil Field Equipment, Generator Plants, Industrial Tractors, Pumps and Compressors, Agricultural Machinery, Railroad Equipment, Saw Mill and Logging Equipment, and Marine Applications.

Got a diesel drive problem?

You'll find the answer in the complete LINK-BELT chain line . . . a size and type for your specific need

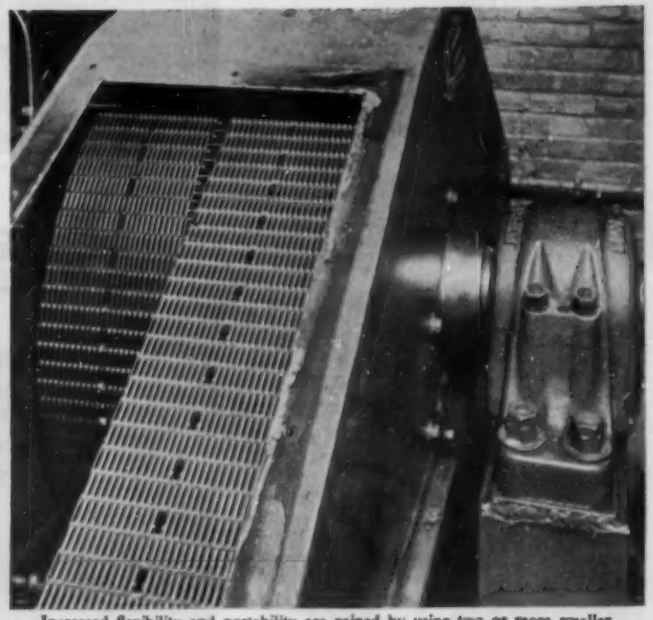
SILENT CHAIN

for high-speed dependability

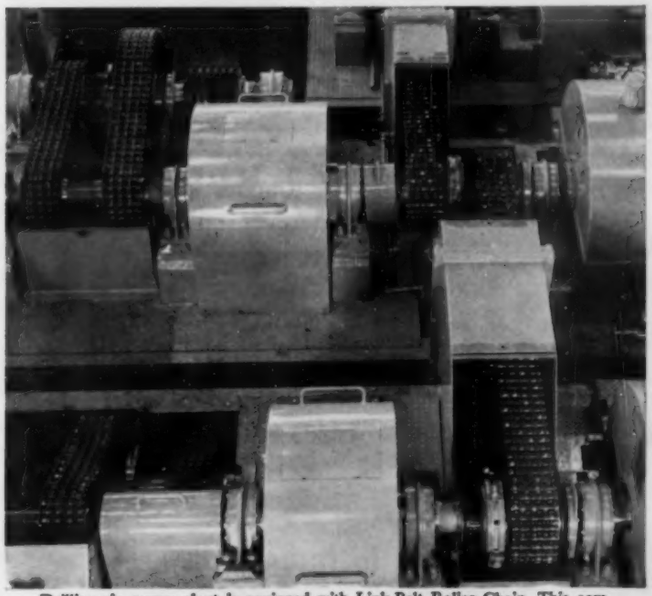
LINK-BELT Silent Chain is generally preferred where steady power flow without slippage is essential. Tooth-to-tooth action maintains exact ratios, gives you better than 98% efficiency.

There are other sound reasons why silent chain is specified for auxiliary drive jobs such as compounding, exciter drives, power take-off and conversion. First cost is often lower . . . lifetime cost is *nearly always* lower. You save on installation expense because silent chain is simple to handle . . . can be assembled quickly in limited space. Service is easy also since no dismantling of machine or removal of sheaves or bearings is necessary.

Compact Link-Belt Silent Chain drive operates exciter on this 840-kw Fairbanks-Morse generator in Kansas. Two other drives operate on 375-kw and 181-kw generators. Positive action gives long, efficient service.



Increased flexibility and portability are gained by using two or more smaller diesels instead of one larger engine. Here dependable Link-Belt Silent Chain connects four 175-hp engines to drive shaft.



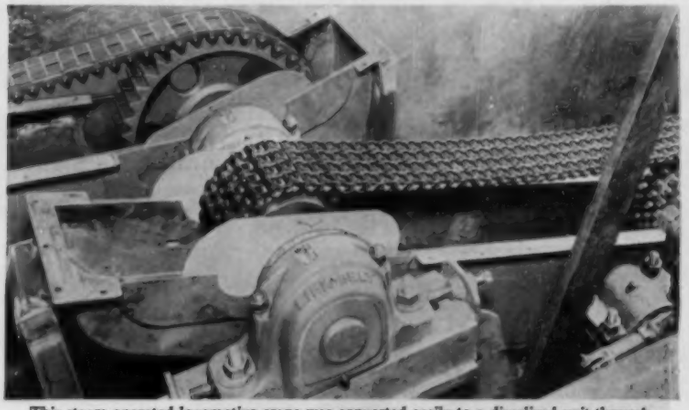
Drilling rig power plant is equipped with Link-Belt Roller Chain. This compound transmits 3350 hp through Link-Belt precision steel roller chain drives.

ROLLER CHAIN

for lasting precision

Precision construction and ability to "take it" make Link-Belt Roller Chain the ideal choice for compounding and conversion drives. Extra life is built-in these four ways: 1) Rollers are shot-peened for ability to withstand impact and fatigue 2) Closer heat-treat control—coupled with extensive and continuous testing — insures uniformity 3) Lock-type bushings eliminate a common cause of stiff chain 4) Pre-stressing provides uniform load distribution.

All these extras are yours at no extra cost on every length of Link-Belt Precision Steel Roller Chain.



This steam-operated locomotive crane was converted easily to a dieselized unit through use of Link-Belt chain. To utilize best features of each type, primary drive uses Silent Chain; secondary drive is equipped with Roller Chain.

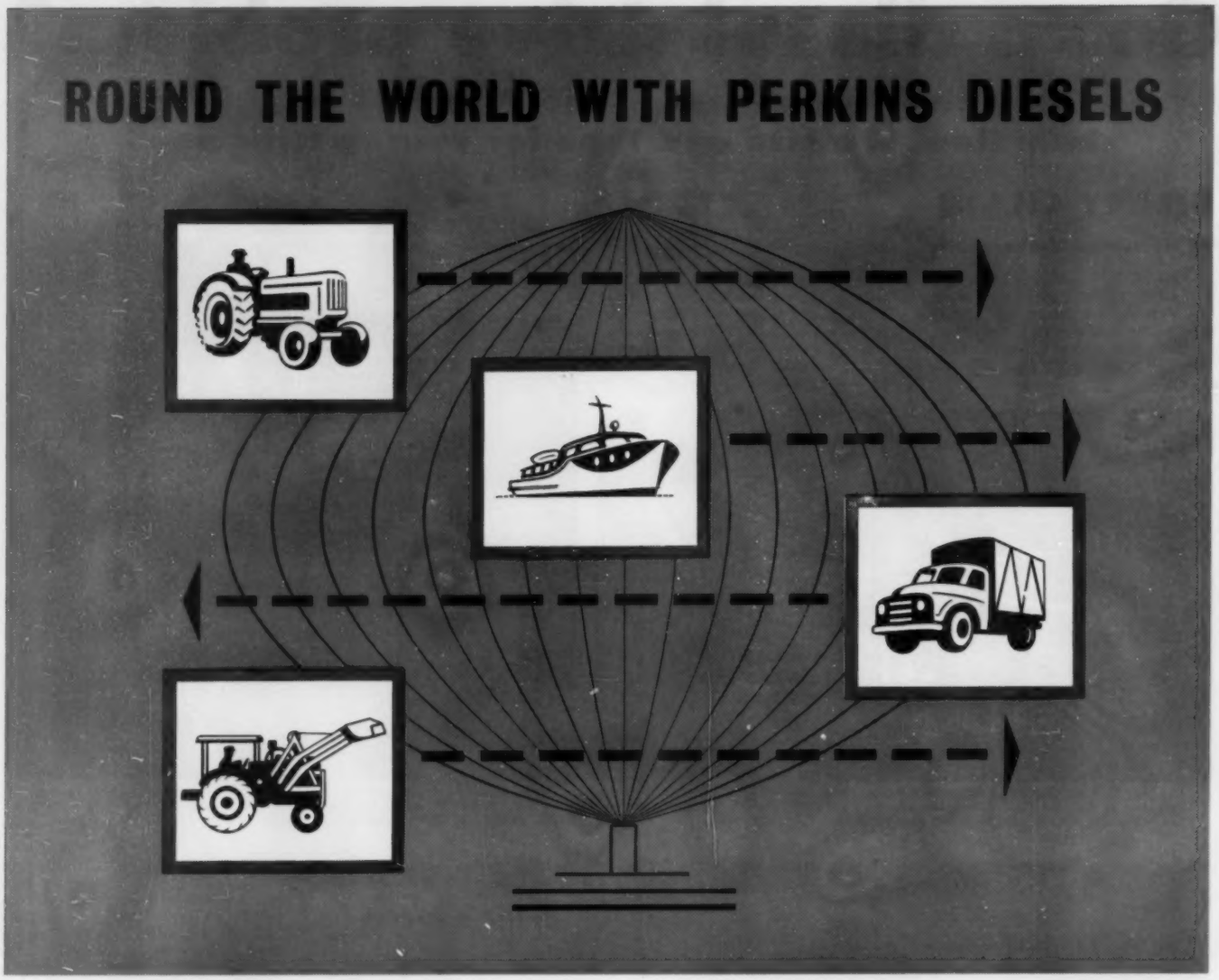
Bring your diesel drive problems to Link-Belt. Our engineering staff, backed by 80 years' manufacturing and application experience, can solve them quickly, efficiently, and at lower cost to you.

LINK-BELT COMPANY: Executive Offices, Dept. DEC-57, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,041

LINK-BELT

CHAIN DRIVES

ROUND THE WORLD WITH PERKINS DIESELS



In the depths of Canada's forests, or in the Australian bush, high up in the Chilean Andes or in the busy streets of India's cities, you'll find Perkins Diesel engines at work. Tropic heat or arctic cold—it's all one to Perkins Diesel engines, for these rugged economical power units are designed specially to stand up to the toughest conditions. Whatever the job, wherever it may be, every Perkins engine is backed by the famous Perkins world-wide service and spares organisation. For vehicle, industrial, agricultural or marine use Perkins Diesel engines are unsurpassed.

Power Range 20 to 104 B.H.P. Torque Range 101 to 240 lbs. ft. 14 to 33 Kgm.

Perkins HIGH QUALITY DIESELS

For Power Standardization in Industrial, Vehicle, Agricultural and Marine Applications

The Diesel Engine with the Clean Exhaust **F. PERKINS LIMITED • PETERBOROUGH • ENGLAND**

AUSTRALIA
Perkins Diesel (Overseas) Pty. Ltd., Princes Highway, Dandenong, Victoria. Tel: 1377/8. Cables: Perkoil Dandenong.

CANADA
F. Perkins (Canada) Ltd., 60 Wingold Avenue, Toronto 10, Ontario. Tel: Russell 1-4415/6/7. Cables: Perkoil, Toronto.

SOUTH AFRICA
F. Perkins (S.A.) Pty. Ltd., P.O. Box 9951, 156 Main Reef Road Johannesburg, S. Africa. Tel: 24-3087. Cables: Perkoil, Johannesburg.

FRANCE
Société Française des Moteurs. F. Perkins, 9 et 11 Rue d'Enghein, Colombes (Seine). Tel: Charlesbourg 35-60. Cables: Perkoil Paris.

DEMCO
Fuel Injection Equipment

FEATURES:

1. Larger capacity than any comparable model of other make.
2. Dimensions interchangeable with other makes.
3. The ultimate in precision.

DEMCO INDIVIDUAL UNIT FUEL INJECTION PUMPS

Model "PF" Pumps, port controlled type with plunger sizes from 6 mm. to 22 mm. Self-contained units for flange mounting on Diesel engines.

DEMCO MULTIPLE UNIT FUEL INJECTION PUMPS

Model "2PB" Pumps, port controlled type, built in sizes from 2 to 8 pump units. They are built with range of plunger diameters from 6 mm. to 13 mm., in millimeter steps. Pumping unit assemblies can be removed without disturbing other parts or requiring recalibration. No special tools needed for maintenance. Operates in either direction. Supplied with governor.

DEMCO "IPFNB" PUMPS

Low cost pumps especially designed for small Diesel engines. Simple design and construction. Smaller overall dimensions. Can be replaced without retiming or changing fuel quality control.

DEMCO NOZZLES

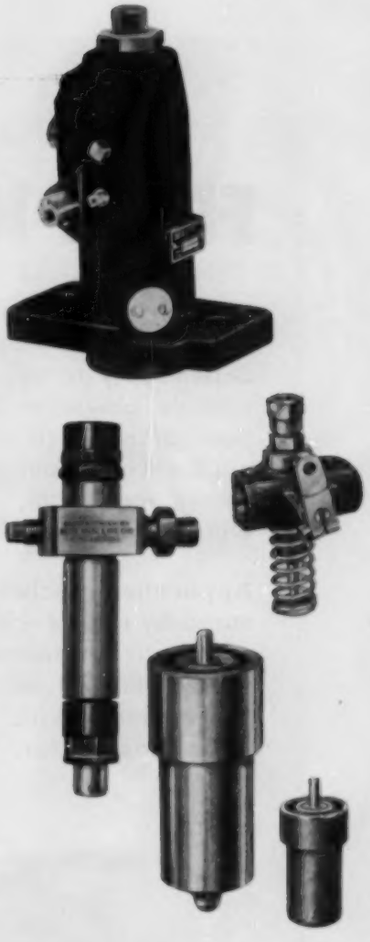
Differential closed type, hydraulically operated. A full line of multi-hole nozzles in three sizes with diameters of .547", .700" and .979" respectively. Also—pintle nozzles for Diesel engines of the divided combustion chamber type, two sizes with diameters of .507" and .547" respectively. Standard or special corrosion proof material, depending on individual engine requirements.

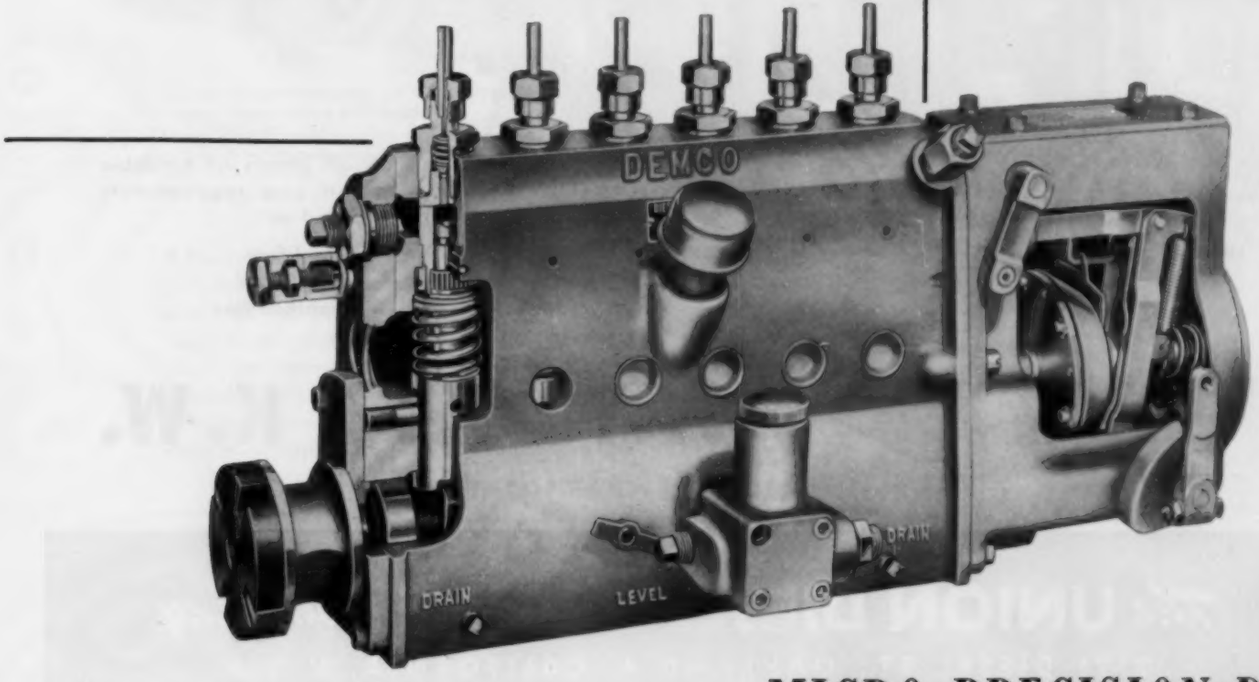
DEMCO NOZZLE HOLDER ASSEMBLIES

These nozzle holders are supplied in four standard shank diameters and various lengths to suit any engine conditions. They can be supplied with special bleeder valves for venting the fuel passages.

DEMCO SPECIAL FUEL INJECTION EQUIPMENT

As an outgrowth of its precision specialization experience and flexibility of its modern shop facilities, DEMCO is prepared to design and manufacture fuel injection equipment to customers' individual specifications. As always, DEMCO Engineering means prompt and completely satisfactory service.





MICRO-PRECISION Div.

of MICROMATIC HONE CORPORATION

2205 LEE STREET • EVANSTON, ILLINOIS

FROM 100 K.W....

UNION Diesel generating sets are conservatively designed, carefully built and dependably rated. They provide more reliable power at lower cost. Installations both afloat and ashore throughout the world have proved that their use assure maximum, long-lived economy with minimum maintenance.

Applications include stand-by service with automatic controls as well as main line power source with high load factor.

UNION Diesels are available to suit your requirements arranged as

Dual Fuel
Full Diesel
Sparked Gas

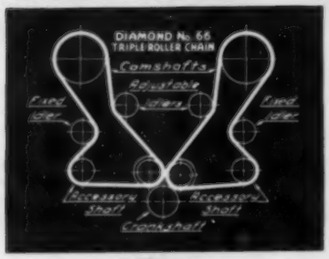
...TO 1250 K.W.

The UNION DIESEL ENGINE *Company*

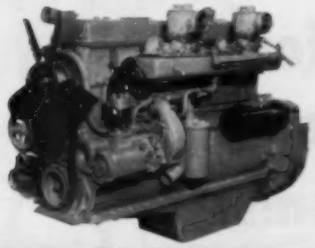
2121 DIESEL ST., OAKLAND 6, CALIFORNIA, U. S. A.

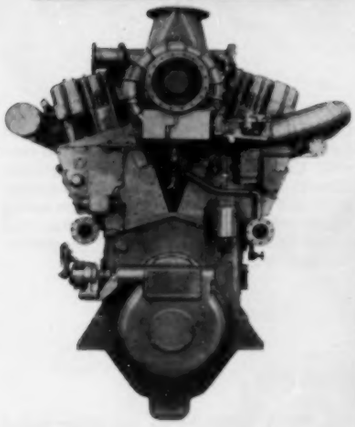
FOR BETTER PERFORMANCE—AND ECONOMY
DIAMOND ROLLER CHAINS

TIMING AND AUXILIARY ENGINE DRIVES

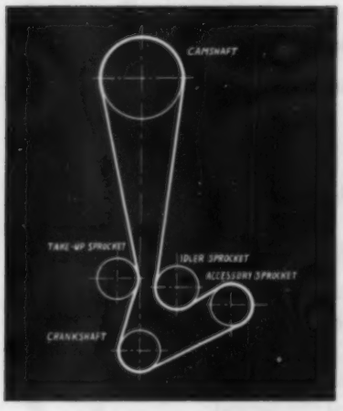


The new Hall-Scott 590 six cylinder truck engine, available for gasoline or LPG, delivers over 200 horsepower, weighs less than 1,300 pounds and is under 50 inches in overall length. 182 pitches of Diamond No. 82 quadruple-strand Roller Chain drive the overhead camshaft as shown below.

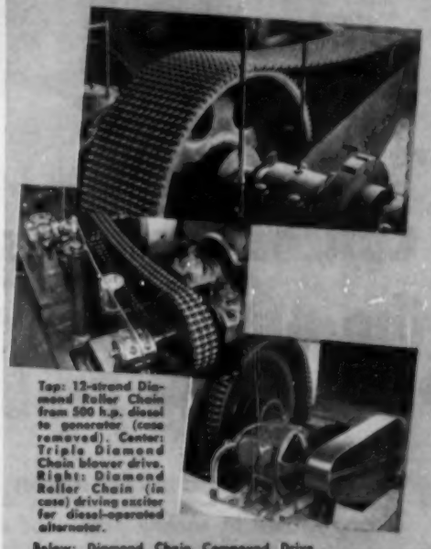




On the Cooper-Bessemer L.S.V. Engine, Diamond No. 470 quadruple Chain is installed from the timing drive camshaft to intermediate shaft and Diamond No. 148 for the auxiliary drive.

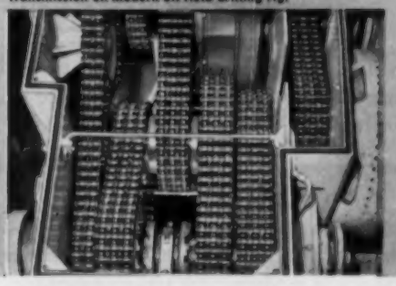


POWER TAKE-OFF and COMPOUND DRIVES



Top: 12-strand Diamond Roller Chain from 500 h.p. diesel to generator (case removed). Center: Triple Diamond Chain blower drive. Right: Diamond Roller Chain (in case) driving exciter for diesel-operated alternator.

Below: Diamond Chain Compound Drive Transmission on modern oil field drilling rig.



• For over a quarter century the use of Diamond Roller Chains has included many applications on all types of engines: — gas, gasoline, diesel and dual-fuel up to 5000 h.p. and at speeds as high as 10,000 r.p.m. in stationary, marine and land transportation service. Wide usage has demonstrated their unmatched long-life reliability, high maintained efficiency and smoothness of operation. Efficiency remains practically the same throughout long service. The finish of working surfaces improves with scarcely measurable wear.

And These Definite Diamond Advantages

1. Adaptability to wide range of shaft centers, speeds, and ratios.
2. Drive from either face.
3. Create no end play.
4. Make close shaft centers and clearance tolerances unnecessary.
5. Quiet when installed — Remain quiet.
6. Low in first and final cost.

DIAMOND CHAIN COMPANY, Inc.
407 Kentucky Avenue, Indianapolis 7, Indiana

Diamond Engineers offer complete design and application service.

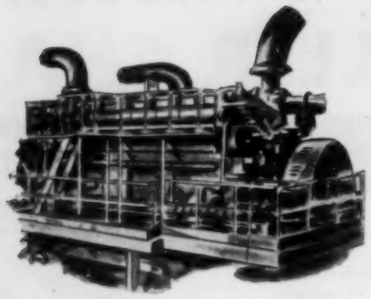
ALWAYS PRELOADED

For many, many years, Diamond Chain has been preloaded after assembly for the purpose of bringing pin-bushing seating into stabilized relationship prior to field installation.

DIAMOND ROLLER CHAINS

SHOT-PEENING SINCE 1944

Diamond Chain has long recognized that certain types of internal stressing of chain parts would increase fatigue resistance. To this end, link plates have been specially processed and chain rollers and other parts have been shot-peened since 1944.



Here's why it pays to

Call on Koppers for the Answers to your Piston Ring Problems!

American Hammered Piston Rings are made in every size • of every type • for every purpose

Every Diesel and gas engine presents a different piston ring problem. So it pays to go to the source that can look for the answer from every angle . . . Koppers American Hammered!

In one completely modern plant, American Hammered produces rings for every industrial application . . . in sizes ranging from less than one inch to ten feet in diameter. Ready to serve you are large foundries equipped for both static and centrifugal casting . . . a modern heat-treating plant . . . one of the largest and most up-to-date chromium plating plants . . . modern machine shops . . . an efficient engine test laboratory . . . a modern and complete piston ring research laboratory!

Outstanding product quality, assured by trained metallurgical and engineering staffs . . . supplemented by field engineers, thoroughly familiar with ring applications . . . results in efficient service and analysis of your specific problems. Write, wire or phone for experienced help on your piston ring problem! KOPPERS COMPANY, INC., *Piston Ring Dept.*, 1415 Hamburg Street, Baltimore 3, Md.

COMPRESSION RING is a one-piece, quick-seating piston ring. One-piece construction gives maximum strength. Turned finish on outside diameter enables ring to conform readily to cylinder bore. Chemically treated surfaces promote rapid seating with freedom from scuffing or scoring during run-in. ½″ to 120″ diameters.

POROUS CHROMIUM PLATED piston rings are manufactured by the exclusive Van der Horst process. Produced with a shallow porosity on the cylinder contacting surface, this ring facilitates break-in, holds and distributes oil during this critical period. Lasts four times longer and cuts cylinder wear up to 75%. ½″ to 42″ diameters.

CONFORMABLE OIL RING maintains constant unit pressure for positive oil control. Conforms readily to meet cylinder distortion because flexible cast iron member is pressed outward by abutment type spring which exerts uniform radial pressure around entire circumference. 4″ to 25″ diameters, ¼″ min. width.

KOPPERS SEAL RING has either one or two projecting bands of bearing bronze inserted in its cylinder contacting face. High unit pressure on narrow bronze bands takes quick initial seat, tends to prevent blow-by in both new or worn cylinders. Burnishing action of bronze on cylinder walls decreases scuffing and wear. 2″ to 30″ diameters.

GROOVED OIL CUTTER RING has been adopted as standard equipment where oil control has previously been a major problem. Unique design incorporates two bevels for riding over oil on upstroke, two scraping edges for removing excess oil from cylinder walls on downstroke, plus a series of wide drainage slots. 1½″ to 25″ diameters.

PLUS RING MATERIALS to fit every need, such as: K-IRON®, a high grade, closely controlled, individually cast grey iron used in majority of applications . . . and K-SPUN®, a malleable type iron, centrifugally cast for applications requiring high strength, high elastic modulus and superior impact resistance.

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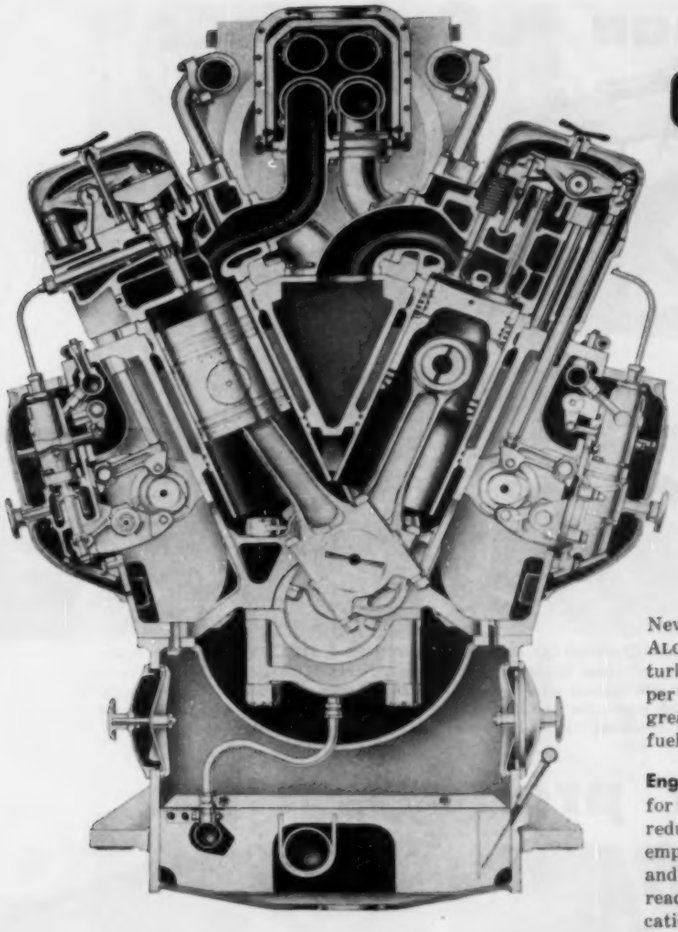
Industrial Piston Rings

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE, MD.

FOR STATIONARY OR MARINE SERVICE MODERN ALCO 251 DIESEL



Cross section of vee model ALCO 251 diesel

New standards of diesel-engine performance are set wherever ALCO's 251 diesel is in service. Improved fuel injection, modern turbocharging and an air aftercooler result in more power per pound. A four-stroke cycle provides better combustion for greatly increased power at less first cost, with lower over-all fuel and lube consumption.

Engine weight is reduced through use of rugged weldments for base and block. The four-point mounting simplifies and reduces the cost of installation. Modern, proved materials are employed in the power section of the 251, reducing maintenance and extending the life of the engine. The basic ALCO 251 is readily suited to a wide variety of stationary or marine applications by adding standard modification materials.

Availability of parts and service is assured by ALCO's seven regional warehouses across the country. All 251 models have interchangeable parts, so your parts inventories are minimized.

Get more information about the unusual savings from the ALCO 251 diesel by calling your nearest ALCO sales office. Or write for Bulletin DE-6. Transportation Products Division, Dept. TR-7, P. O. Box 1065, Schenectady 1, N. Y.

Condensed Specifications for ALCO 251 Diesels

No. Cyl.	Bore and Stroke (in.)	RPM	BHP	Approx. Wt., Dry (lb)	Approx. Wt., Dry (lb) Marine
6	9 x 10½	350-1000	550-900	22,100	26,000
12	9 x 10½	350-1000	1100-1800	32,650	33,500
16	9 x 10½	350-1000	1470-2400	42,000	43,500

ALCO

ALCO PRODUCTS, INC.

NEW YORK

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Locomotives • Diesel Engines • Nuclear Reactors
Heat Exchangers • Springs • Steel Pipe • Forgings
Weldments • Oil-Field Equipment

More than 100 famous

THE GALION IRON WORKS MFG. CO. is a well-known maker of motor graders using International heavy-duty carbureted and diesel engines.

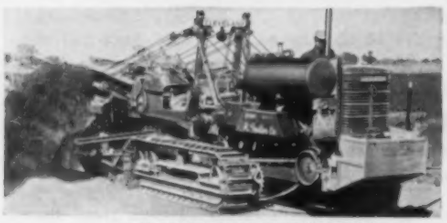
equipment manufacturers

BUCYRUS-ERIE offers International engines in the broad line of shovels and construction tools the construction industry buys in volume from this famous manufacturer.

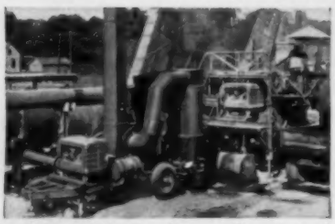
IOWA MANUFACTURING CO. makes the well-known line of Cedar Rapids crushers. Pamper-proof International diesel engines, known for high production and low maintenance, are available for their models.

WARNER & SWASEY make the do-everything Gradall® that trenches, grades, excavates, ditches, stockpiles, lifts, and loads. This famous firm solves engine problems the sure way—with International power.

power their products with



THE CLEVELAND TRENCHER CO. makes sure their models have the power for hard digging even in frozen and rocky ground without expensive maintenance downtime by making them available with International heavy-duty 4-cycle diesel engines.



BARBER-GREENE makes a wide variety of products, including this Model 845 High Type Continuous Mix Asphalt Plant. They give customers the operating dependability and economy they prefer with International power units.

SCHRAMM is known everywhere as a compressor manufacturer and products like this Model 315 are available with International diesels to keep production high and operating costs low year after year.

International® Engines

You, too, can specify International power and get the benefits of over 55 years of heavy-duty engine design and manufacturing experience. You'll get a full measure of dependable and economical power for your customers.

Our experienced installation engineers are ready to help you with your power needs. Pilot engine models are available for your research and testing programs.

These services are only surpassed by International's world-wide service facilities in the field...anywhere. That's why more than 100 equipment manufacturers power their products with Internationals. Join these shrewd power buyers by calling or writing us today.

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International Harvester Company
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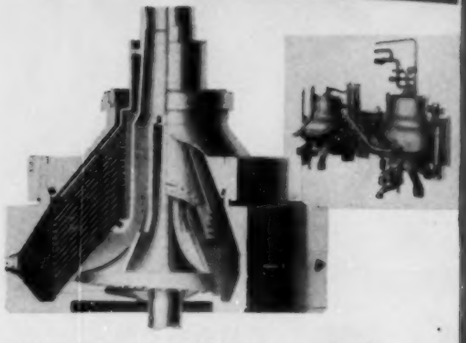
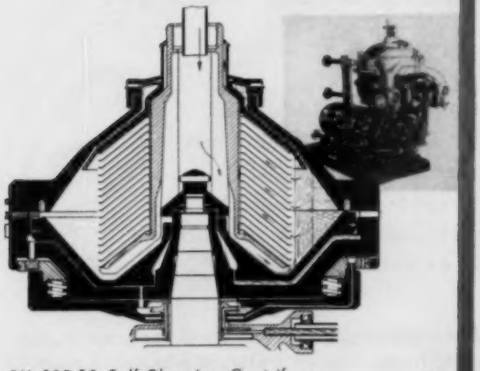
A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors . . . Self-Propelled Scrapers . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Haulers . . . Diesel and Carbureted Engines . . . Motor Trucks . . . Farm Tractors and Equipment.

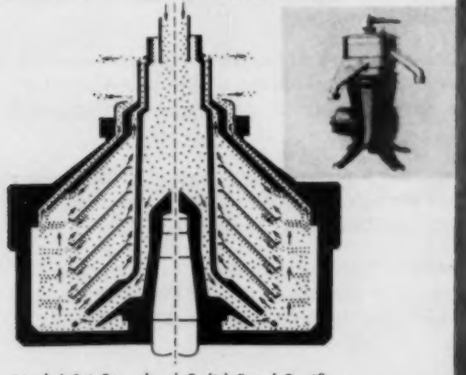
IF YOU CAN PUMP IT, WE CAN PURIFY IT.....



AC-VO "Nozzle-Matic"® Continuous Purifier



PX 209.00 Self-Cleaning Centrifuge



Model 94 Standard Solid Bowl Purifier

CONTINUOUSLY!

Only De Laval offers you every type of heavy fuel oil centrifuge . . . for *both* small or large size plants—ashore or afloat!

Take your choice! . . . select the type that precisely fits your requirements . . . gives you greatest economy.

All three De Laval Heavy Oil Purifiers have demonstrated their efficiency *in service* . . . have proved they do their job so well that the savings are *actual*, not dissipated in added maintenance expense.

Complete details on request . . . without obligation.

RECOMMENDED CAPACITIES—G. P. H.

VIS.	TEMP.	AC-VO	PX 209. F	MODEL 94
500	180° F	1200	600	300
700	180° F	1100	550	275
1700	180° F	660	330	165
2500	180° F	560	280	140
4000	190° F	440	220	110
5000	200° F	300	150	75

DE LAVAL SEPARATOR COMPANY

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7 NEW, LIGHTER WEIGHT FILTERS

1261-E-69 1661-E-69 1961-E-69 1960-E 8-931-E 8-931-E1 16-931-E

The finest filters weren't good enough. So . . . Winslow made them even better!

Already the pioneer and basic patent holder for many of the most significant advances in fuel and lubricating oil filtration, Winslow once again demonstrates its leadership by introducing these seven new, lighter weight filters for automotive and industrial engines. Used singly or in multiples, at least one of these newly engineered filters will give *your* engine improved protection against the impurities found on lubricants, fuels, air, water and gases. More than ever, it pays to *insist on Winslow*. Here's why:

REDUCE EXCESSIVE HEAT IN LUBE OILS!

A properly installed Winslow Full-Flow Filter helps keep your lube oil cool in two ways: **First,** if installed externally or directly in the air stream from your fan, the filter provides air cooling for the oil. **Second,** the capacity of the filter, added to the capacity of your crankcase, means that with Winslow full-flow filtration you have a greater oil reservoir and therefore do a better job of ridding the engine of excessive oil heat.

GREATER GPM RANGE—Select the filter designed for your engine. With oil flowing freely through a filter of adequate capacity, your engine cannot suffer from lack of proper lubrication, nor will it overheat as readily.

CONTROLLED PRESSURE—You get more *positive protection* from Winslow Full-Flow Filters because of the patented "CP" Element, with its self-contained, dual capacity, Controlled Pressure flow.

LIGHTER WEIGHT—Profiting from experience gained in developing Winslow's famed aircraft engine filters, these new models are lighter in weight and thus easier to install.

ELEMENTS CHANGED EASILY—The specially designed clamp and "O" ring seal have made it possible to remove the filter lid more easily and change elements with less loss of time.

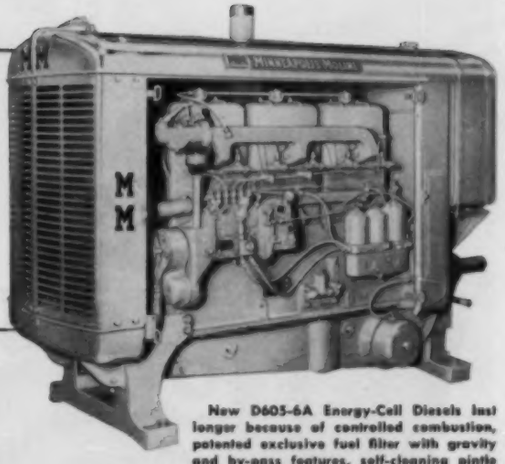
For complete information, write today to

WINSLOW ENGINEERING & MANUFACTURING CO.
4069 Hollis Street, Oakland 8, California

WHY IT PAYS TO OWN INDUSTRIAL DIESELS WITH REMOVABLE CYLINDER BLOCKS AND HEADS

New MM diesels were developed with *energy-cells* to make them last longer, do more and go farther with less down-time and maintenance.

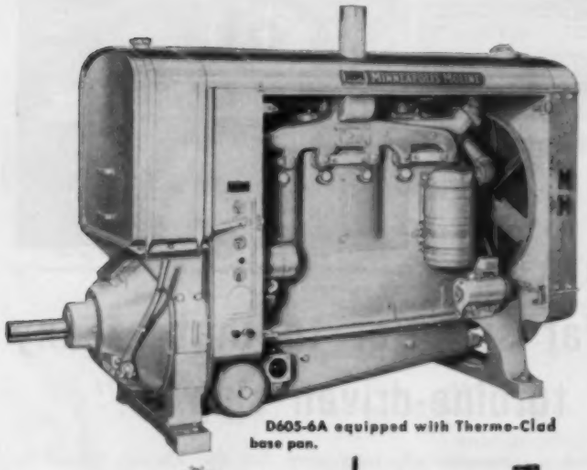
To provide owners with lower cost maintenance when necessary MM diesels are the most advanced and soundly engineered because the cylinder blocks are cast in pairs separate from the crankcase.



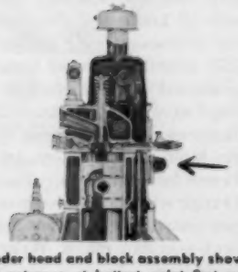
New D605-6A Energy-Cell Diesels last longer because of controlled combustion, patented exclusive fuel filter with gravity and by-pass features, self-cleaning pintle type nozzle, directed cooling of area around combustion chambers.

YOU GET THESE ADDED ADVANTAGES . . .

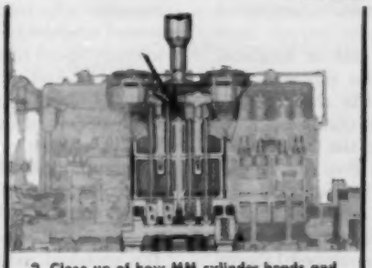
1. Ease of maintenance and low cost emergency service because paired cylinder blocks, pistons, and rods can be removed as a unit by one man.
2. Prolonged time between overhauls by use of close-grain cast iron that provides best cylinder lubrication for reduced wear.
3. Less service due to minimum distortion as MM cylinder heads, cylinder blocks and crankcase are virtually strapped together by full-length steel studs anchored in the main bearing bulkheads. (Transmits combustion pressure to heavy crankcase that has extra depth below center line of crankshaft.)
4. Efficient operation obtained by uniform cylinder expansion . . . the result of controlled cooling and long oil-cooled cylinder wall skirts below ring travel area.
5. "New engine" performance at extremely nominal cost can be obtained right in the field without special tools using factory matched cylinder blocks, pistons, pins, and rings. (Blocks are dowelled to crankcase to assure bore is square with crankshaft and pistons are precision fit to bore . . . equivalent to a factory job.)
6. Lower initial cost stems from high production parts by casting cylinder blocks in pairs separate from the crankcase.



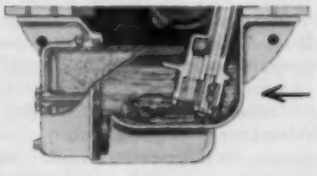
D605-6A equipped with Thermo-Clad base pan.



1. Cylinder head and block assembly shows coolant entrance at hottest point first and extra long skirt wall construction.



2. Close-up of how MM cylinder heads and blocks and crankcase are tied into a single rigid unit with long studs.



3. A D283 feature is extra large oil filter enclosed in base pan, floating-screen oil pump intake, and pump located in bottom of base pan.

Optional Thermo-clad water-blanketed base pans for all units also have oil filter included to give more effective filtering.

INDUSTRIAL POWER DIVISION

MINNEAPOLIS-MOLINE

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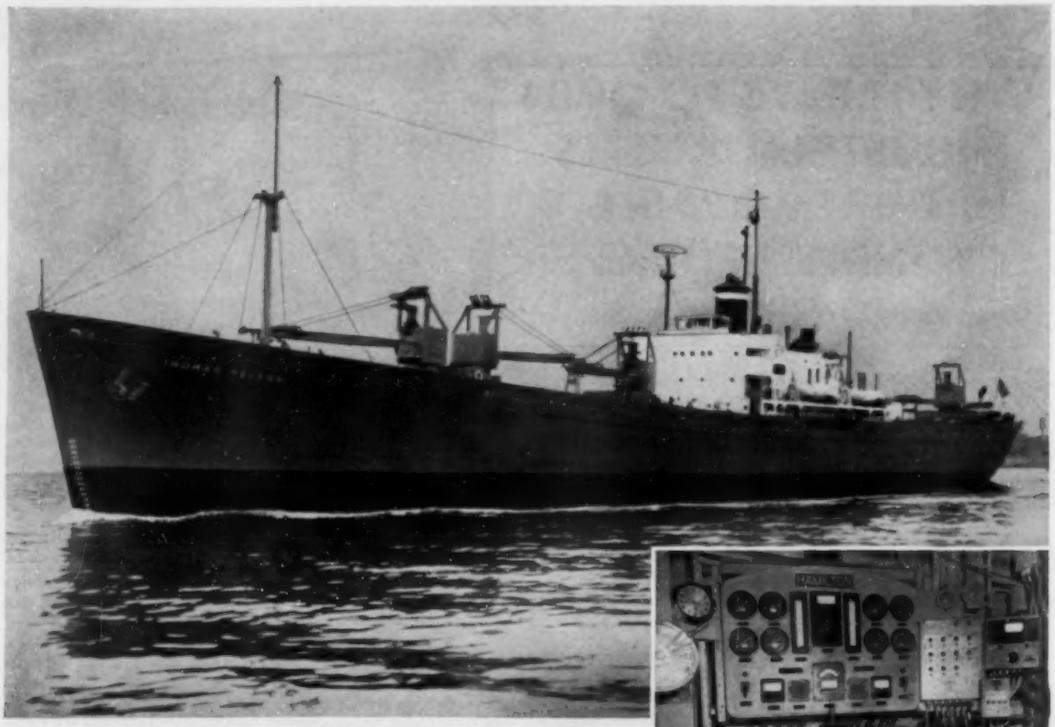
THE GOLDEN POWER LINE



Converted Liberty ship *Thomas Nelson*, equipped with two new Hamilton 7-cylinder diesels.

Compact control panel contributes to quick, sure maneuvering.

"The maneuverability of the *Thomas Nelson* is far superior to that of any steam reciprocating or turbine-driven ship . . ."

Captain W. J. Taylor voiced this impressive conclusion following the *Thomas Nelson's* maiden voyage from Norfolk, Va., to various points of call in England, France and Holland. The captain also reported that all six foreign pilots who operated the ship in their respective ports praised her handling qualities.

In one instance, while negotiating the Manchester ship canal, another freighter failed to give the *Thomas Nelson* the right-of-way. Only because "propeller rotation changes are practically instantaneous" with the *Thomas Nelson* was it possible to avert the collision that would have been inevitable with a normally equipped Liberty.

Not only are the two Hamilton 7-cylinder engines exceptionally responsive, but the *Thomas Nelson* attained a speed of nearly 18 knots and maintained an average speed of nearly 16 knots during the two ocean crossings. And only .375 pound per brake horsepower-hour of black oil is consumed in these engines. In fuel costs alone, the ship could save $180,000 annually.

We welcome your inquiries regarding these and other Hamilton- and Baldwin-built diesels. There are B-L-H stationary or marine diesels for virtually any installation in the 550 to 7200 hp range which can save you money in fuel and maintenance costs. B-L-H diesels are by far the soundest investment you can make. Write or call today for detailed information.

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Miami 36, Florida Diesel Service Co., 1930 North Miami Ave.

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Milwaukee, Fuel Injection & Electric, Inc., 934 N. Jackson St.

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BRITISH COLUMBIA

Vancouver, Fred Holmes Fuel Injector Sales & Service, Ltd., 627 Bidwell Street

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Fredericton, Stairs Brother, 493 Northumberland Street

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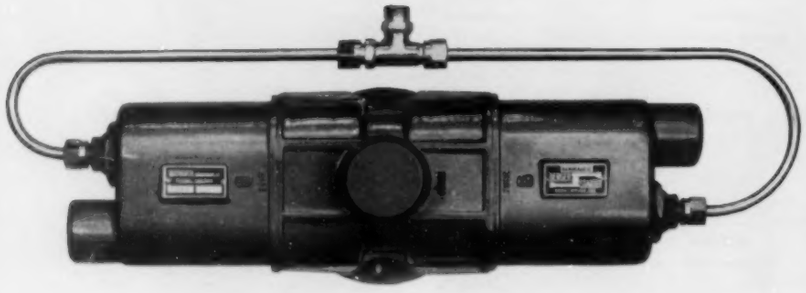
BERGER
HANDRAULIC STARTER



Yes, without either batteries or any outside source of power, the Berger Handraulic Starter ensures instant starting the moment the diesel engine is needed, whatever the local conditions may be.
It is a simple flameproof device based on pneumatic and hydraulic principles operating on the free end of the crankshaft. Maintenance is simple, and servicing is available on a world-wide basis. Existing engines can be converted.

Economical running a certainty

THIS with the consistent accuracy of

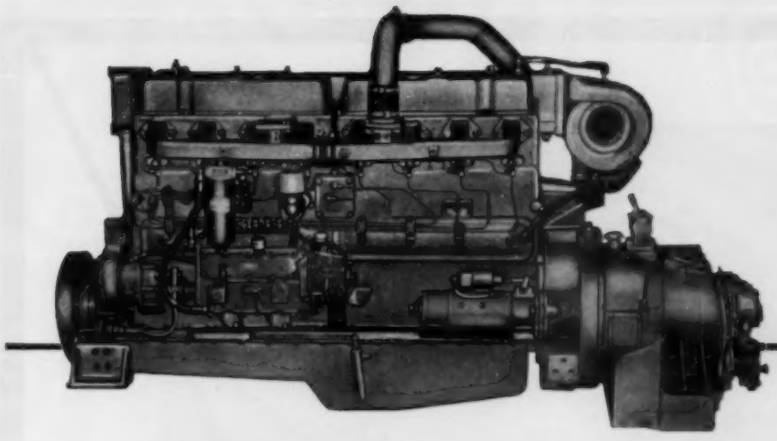
BRYCE
FUEL INJECTION EQUIPMENT

The Bryce Berger factory at Staines is equipped with the most up-to-date machinery available, and its inspection equipment is of the highest possible standards. For instance, the needle of the fuel injector, illustrated here, is surface finished to an accuracy of one millionth of an inch.

Many leading engine makers fit Bryce equipment as standard.

Write now for full details

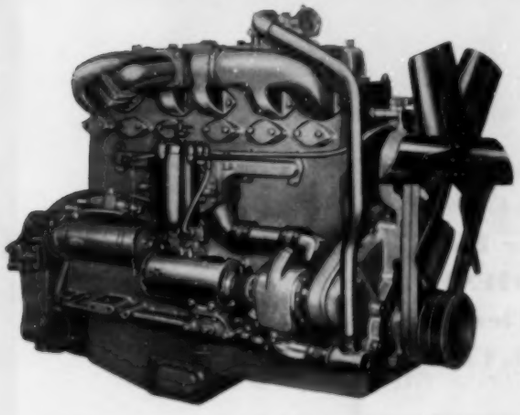
BRYCE BERGER LIMITED, IRONBARKS WORKS, STAINES, MIDDLESEX, ENGLAND · Cables: Injection, Staines, England



Model 8 DATMR-1125 Turbocharged 8-cylinder Diesel Marine Engine. 5¼-in. bore, 6½-in. stroke, 1125-cu-in displacement. Equipped with reverse and reduction gear. Especially designed for dependable and economical service in work boats, tow boats and fish boats.

It's Allis-Chalmers for ANY Engine Requirement

Any fuel — Any size, 9 to 516 hp — Any use

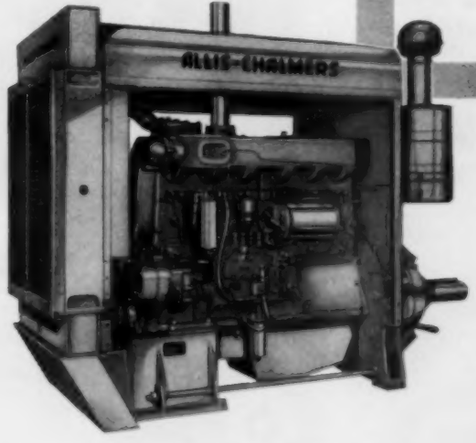


6-cylinder Model 6 DA-779 "Fan-to-Flywheel" Diesel Engine. 5¼-in. bore, 6-in. stroke, 779-cu-in displacement. Provides smooth, efficient power for construction equipment and other heavy-duty applications where dependability is of prime importance.

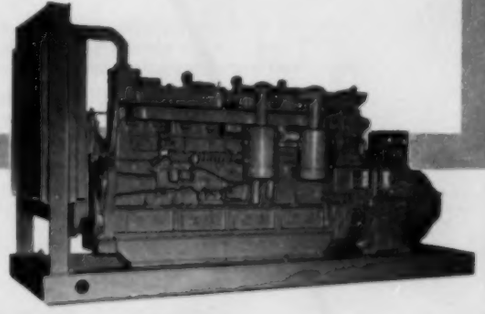
Make your Allis-Chalmers dealer your *main source of power* for all your engine needs. He can supply a wide range of engines for any fuel — gasoline, diesel, LP gas, natural gas — for any use . . . stationary or mobile power units, marine engines, generating sets or fan-to-flywheel engines. Each has the high-efficiency, long-life characteristics necessary for continuous as well as stand-by service. With a high degree of interchangeability of parts, you can use a different type of engine for each application and yet maintain a small stock of parts.

Write for bulletins or see your Allis-Chalmers Engine Dealer for more information.

ALLIS-CHALMERS, BUDA DIVISION, MILWAUKEE 1, WISCONSIN



Model 6DAS-844, 6-cylinder Diesel Power Unit. 5¼-in. bore, 6¼-in. stroke, 844-cu-in. displacement. Provides economical, dependable service on a wide variety of heavy-duty applications.



8-cylinder 8 DCG-2505 Diesel-Electric Generating Set. This unit is one of many Allis-Chalmers Diesel-Electric Generator Sets providing users with economical electricity.

ALLIS-CHALMERS

8E-2

Do You Need Extra Copies of This DIESEL ENGINE CATALOG? If You Do, Send $10.00 For Each Additional Copy Needed To DIESEL PROGRESS, 816 North La Cienega Boulevard, Los Angeles 46, Calif.

Morse Hy-Vo Drives in action on a difficult cotton gin drive installation. Matched 182-HP diesel engines are twinned through Hy-Vo Drives to jack shaft. Jack shaft delivers 364 HP to load shaft (not shown).

GET MAXIMUM HP OUTPUT FROM HIGH-SPEED DIESEL ENGINES WITH MORSE HY-VO DRIVES

The Hy-Vo Rocker Joint provides rolling action with no sliding. This results in minimum wear, heat and friction; giving maximum efficiency. In combination with special involute sprocket teeth, the rocker joint keeps the Hy-Vo Chain tangent to the pitch circle.

Morse Hy-Vo Chain Drives are over 99% efficient at both low and high speeds; transmit up to 5000 HP at speeds up to 8250 FPM, require minimum shaft space, usually eliminating outboard bearings.

With Hy-Vo you can often use a smaller, lower-cost, high-speed engine, or, in many cases, compound two or more high-speed engines, eliminating the need for a big, expensive engine.

For complete information and engineering help, contact your nearest Morse distributor, or write *MORSE CHAIN COMPANY, INDUSTRIAL SALES DIVISION, ITHACA, N.Y.*

IN POWER TRANSMISSION
THE TOUGH JOBS COME TO

MORSE

*Trademark

Alnor EXHAUST PYROMETERS

Type BZ

With Alnor Pyrometer and thermocouple equipment, designed for Diesel engine installations, operators can easily maintain a constant check on operating efficiency, and have a helpful guide to correct maintenance and adjustment. Afloat or ashore, in all types of service, you will find Alnor Exhaust Pyrometers the choice of the majority of Diesel engine builders and users. There is a type and size Alnor Pyrometer to meet the needs of any engine, large or small. Write for Alnor Exhaust Pyrometer bulletin No. 2819 with complete data.

•

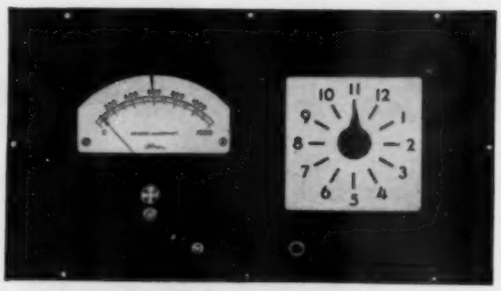
Type BZ, a rugged and accurate multi-point pyrometer with watertight, dust-tight, and fume-proof case. Selector switch of 8 or 17 circuit capacity. Wiring is through conduit hubs at back of case. Type BZ may be installed on switchboard, wall, bracket, or directly on engine.

Type RT

Type RT, a switchboard type for either flush or surface mounting, and conduit wiring at back or bottom of case. Rugged movement provides for consistently accurate service. Case is watertight, dust-tight, and fume-proof. Selector switch capacity for either 8, 17, or 31 circuits. Surface type illustrated; also built for flush mounting.

Type RK

Type RK, a two circuit surface mounting pyrometer especially adapted to exhaust temperature measurements. Can also be furnished with scales suited to measuring cooling water and lubricating oil temperatures, or similar two-circuit applications.



Pyrotac, an automatic pyrometer with motor-driven switch for continuous temperature readings on 6, 11, 12, or 20 circuits. Pyrotac automatically reads all temperature points and will close an alarm circuit (or shut down heater circuit) if any point exceeds pre-set safe temperature standards. Instrument is quickly mounted on any panel—terminal strip wiring makes installation in any circuit a simple matter with just a twist of the screw driver. Send for Bulletin No. 4703.

Thermocouples. Alnor thermocouples for Diesel and gas engine installation are available in a full range of types, both rigid and flexible styles, fixed or quick-detachable, portable styles and portable with adjustable length stem. The needs of any type of engine installation, large or small, can be readily met.

Type FAX, a round case multi-point pyrometer for moderate cost. May be mounted directly on the engine. Splash-proof case. Selector switch capacity up to 16 circuits.

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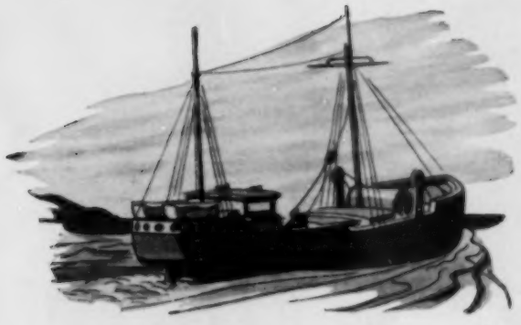

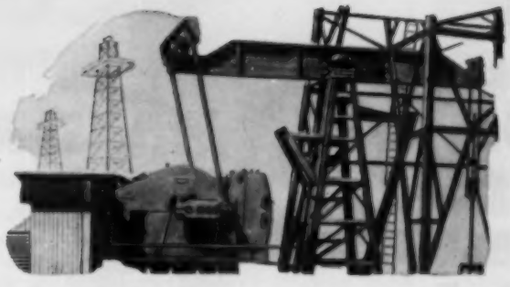

Whatever Your Type of Diesel... Specify

Bendix STARTER DRIVE

There are several definite factors responsible for Bendix* Starter Drive economy: Its simple design lets you mount the starting motor more easily and in more positions. It requires no actuating linkage—has fewer parts—needs fewer adjustments. The solenoid may be mounted in any convenient position. No other starter drive made can match these economy advantages! So whatever your type of Diesel, specify Bendix Starter Drive for economy and all-around performance.

*REG. U.S. PAT. OFF.

ECLIPSE MACHINE DIVISION of Bendix
AVIATION CORPORATION
ELMIRA, NEW YORK

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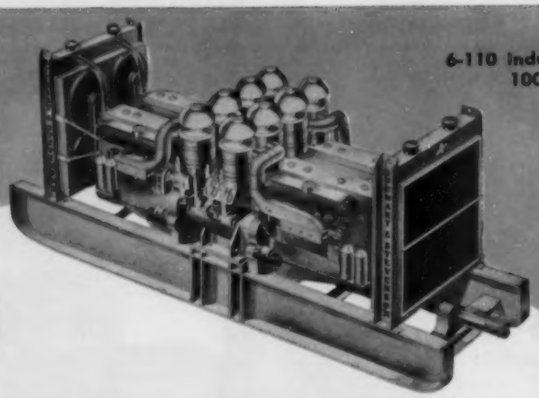
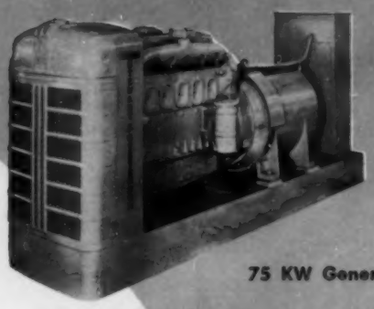
FOR EVERY INDUSTRY



6-110 Industrial Quad
1000 HP



75 KW Generator Set

PARTS • SERVICE

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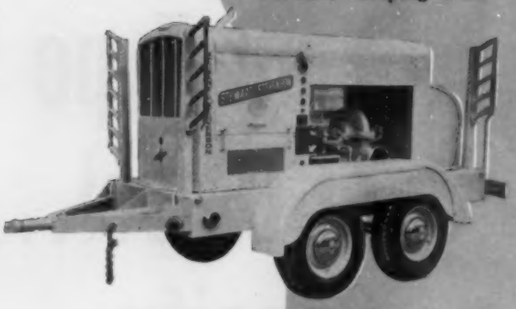
ANYTIME • ANYWHERE

Portable Pumping Units



Whatever your power needs, whatever the application, Stewart & Stevenson can help you if you have a power problem.

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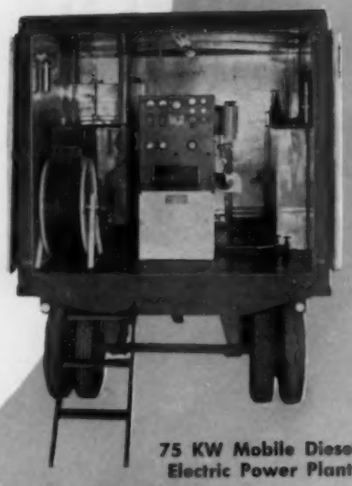
All units can be furnished with either diesel engines or gas, gasoline or butane engines.



75 KW Mobile Diesel Electric Power Plant

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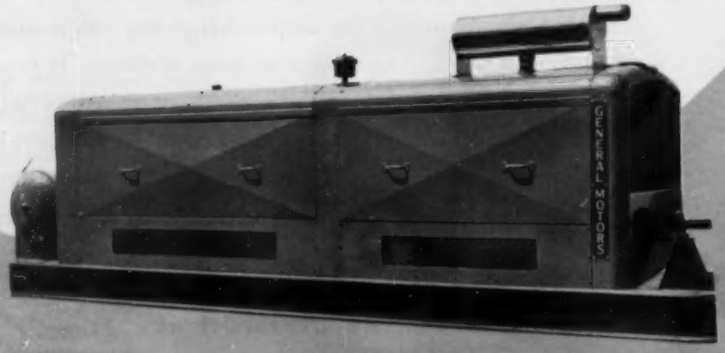


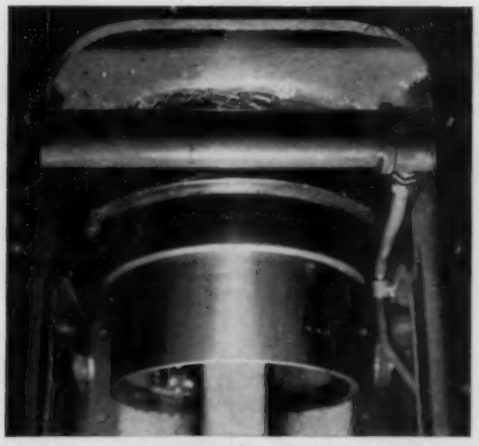
Combination Oil Field Rig Lighting, Welding and Auxiliary Unit

THE WORLD'S LARGEST DISTRIBUTOR OF GM DIESEL ENGINES

(l. to r.) Carl Olbertz, Milford plant superintendent, "Rollie" C. Bleimehl, Standard Oil industrial lubrication specialist and Frank Morgan, Milford chief engineer inspect crankcase. Rollie Bleimehl is qualified to give technical service on jobs like this. He's been doing this sort of work for 10 years. Rollie has a mechanical engineering degree from Iowa State College and has completed the Standard Oil Sales Engineering School.

23,000 hours on original rings and bearings—no overhaul

Milford, Iowa, Light Plant gets this performance from engine using STANODIESEL Oil M



"As is" photo of piston skirt and interior of crankcase. No wiping or cleaning was done before photographing or at any time during 23,232 hours engine has been in service. STANODIESEL Oil M is the lubricant.

When a new 720 H.P. Superior engine was put in service at Milford, Iowa in 1949, the plant management knew what oil they were going to use—STANODIESEL Oil M. Their choice was based on previous experience with Standard diesel oils in other engines.

After 23,232 hours of operation, the engine at Milford is still operating with the original bearings and rings. It has not been overhauled. The crankcase, as shown in the photo, is clean. Pistons are clean and bright with no sign of wear. Twice yearly, oil samples have been taken for laboratory analysis. Each time the analysis has shown the oil to be in perfect condition. Good maintenance and STANODIESEL Oil M have contributed to this performance.

Got a hard job for an oil? STANODIESEL Oil M can do it. STANODIESEL Oil M has superior stability. Its additive formula helps to (1) prevent oil viscosity build-up (2) keep crankcase, pistons, cylinder walls and other parts clean (3) control foam (4) maintain film on difficult to lubricate areas and parts.

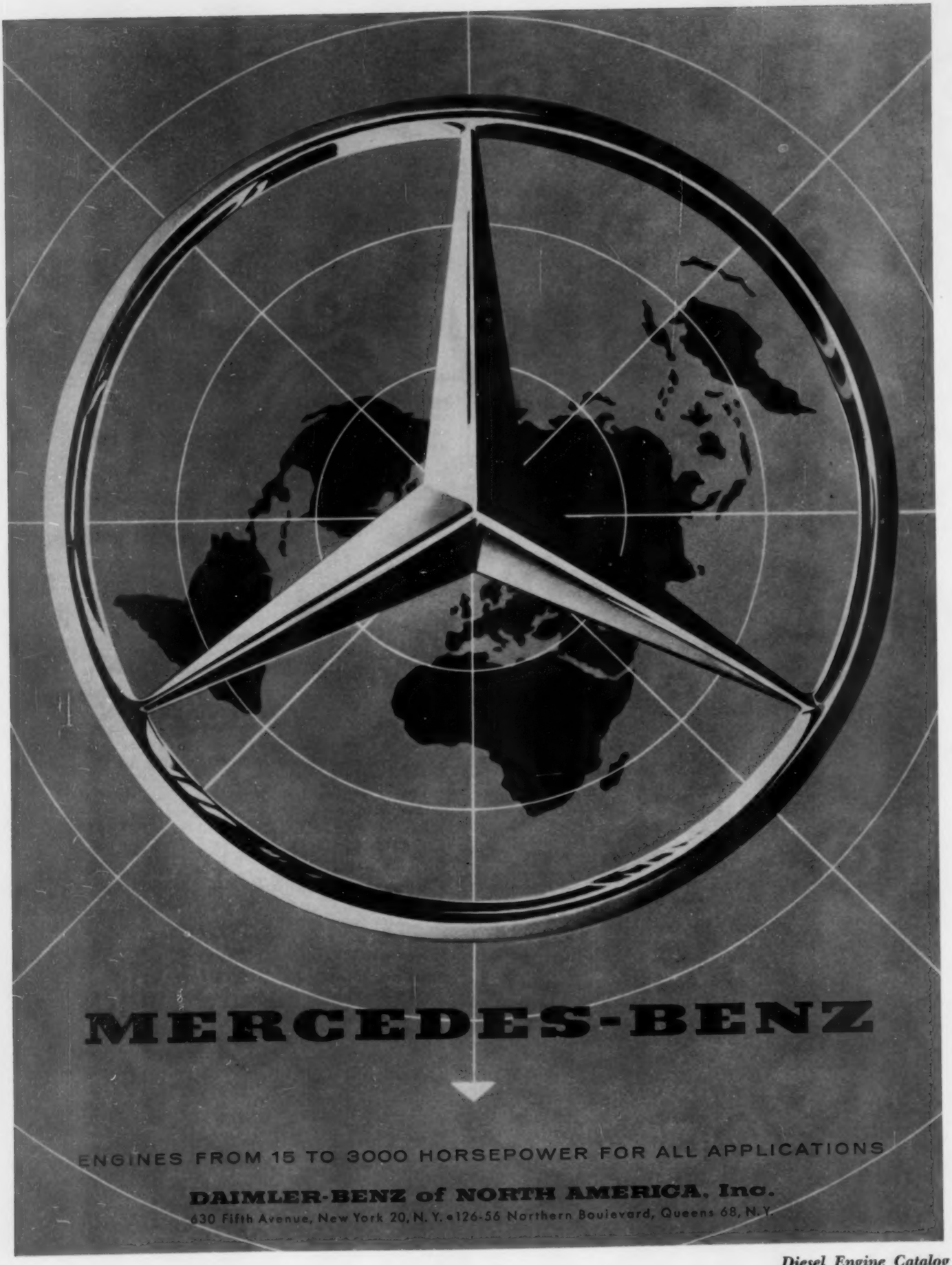
There's a Standard Oil industrial lubrication specialist near you in any of the 15 Midwest or Rocky Mountain States. Call him for more information about STANODIESEL Oil M. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

Quick facts about
STANODIESEL Oil M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by use of economy fuels.
- Maintains film on difficult to lubricate areas and parts.
- Eliminates spark plug fouling in spark ignited engines and reduces combustion chamber ash deposits in engines burning natural gas, LPG and liquid fuels.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil commingle.

STANDARD OIL COMPANY
(Indiana)

STANDARD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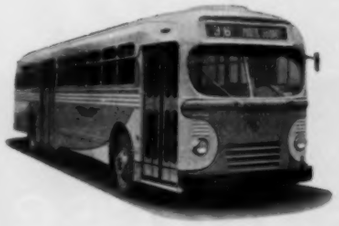

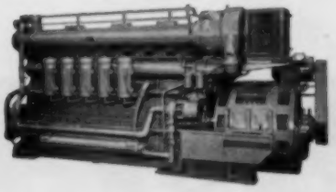

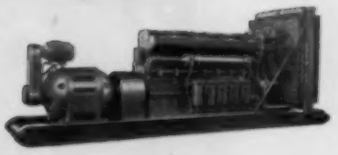

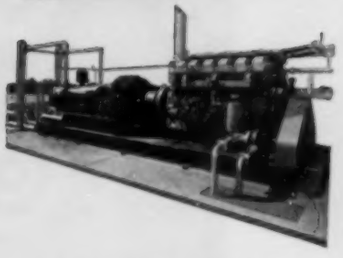

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Name the job — on land or sea! Name the engine — Diesel, gas or gasoline! There's a standard Ross Exchanger that will do the job best for you . . . from a performance standpoint . . . from a design standpoint . . . from a cost standpoint.

No line of exchangers rivals Ross for versatility. No other exchanger is in such widespread use.

From power plants to pipelines, trucks to towboats, buses to bulldozers, oil fields to oil tankers, chemical plants to construction projects . . . on engines large and small, Ross Exchangers keep lube oil, jacket water and torque converter fluid at safe and effective operating temperatures.

Pre-engineering and complete standardization, unequalled in the heat exchanger industry, are the key to the universal preference of Ross Exchangers. Costly specials in engineering and fabrication are eliminated. A wide range of designs, sizes and materials is available, with numerous features for simplifying your specific design problems: Compact shell and tube construction, flexible mounting provisions, light weight, and convenient, accessible connections for easy installation and service.

Learn how Ross Exchangers can meet your requirements by requesting the specific literature listed above. Ross Heat Exchanger Division of American-Standard, Buffalo 5, N. Y. In Canada: American-Standard Products (Canada) Limited, Toronto 5, Ont.

ROSS HEAT EXCHANGER

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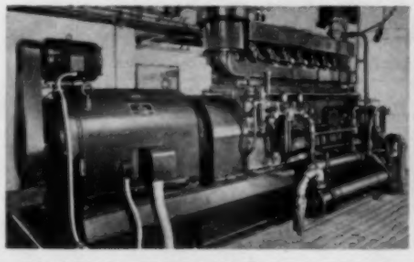
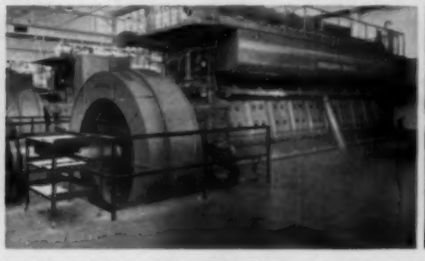
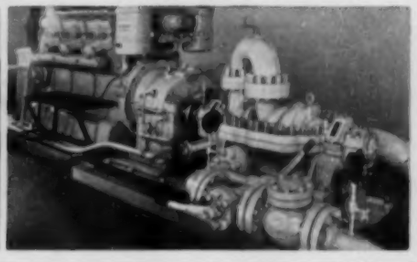
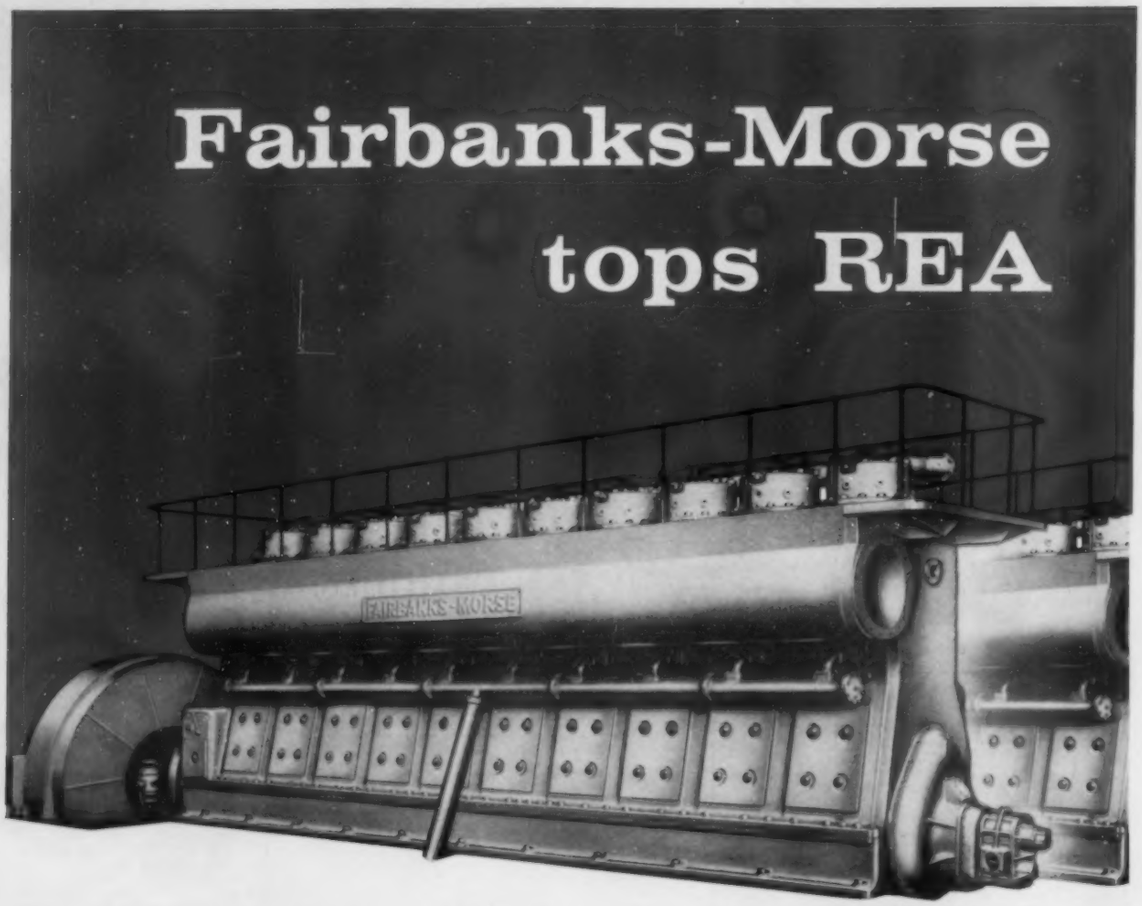






Fairbanks-Morse tops REA



Record 43,300 Hp. Performance

In the top four plants of the national REA competition, there is more than two and a half times as much Fairbanks-Morse horsepower as in all other engines combined—a total of 43,300 horsepower.

Never before has there been such a clear-cut record of efficiency, on such a broad base, in favor of any engine in this competition.

Look at some of the figures:

- First, F-M horsepower produced more than ⅔ of the total power generated by the top four winning plants.
- Three 3500 horsepower Model 31A's generated 82% of the power in the top award-winning Johnson plant.
- Two exclusive F-M powered plants placed second and fourth with only a spread of .1 mill between them.
- One Model 31 in the Top Plant carried the highest penalty of longest operation on straight oil—yet efficiency was higher than plant average.

Here, in engine after engine, is a record of operating standards of efficiency unequaled by any other engine in such numbers.

You Can't Make a Better Power Buy Than a Fairbanks-Morse Diesel or Dual Fuel Engine

FAIRBANKS-MORSE

a name worth remembering when you want the best

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mass efficiency competition

Outstanding Single Engine Performance

Engine No. 6 is one of three Fairbanks-Morse Model 31A 3500 horsepower engines that have helped keep the Johnson plant tops in efficiency for four years*. In winning previously, this engine set a record of 9213 BTU per kw-h—still unsurpassed by any engine today.

That winning record automatically selected the big No. 6 for the heaviest assignment to straight oil operation this year when gas supplies became short. *Yet*, the engine achieved an average of 9642 BTU per kw-h (Better than plant average) and during one period of operation maintained, an average of 8652.

That's approximately 40% thermal efficiency!

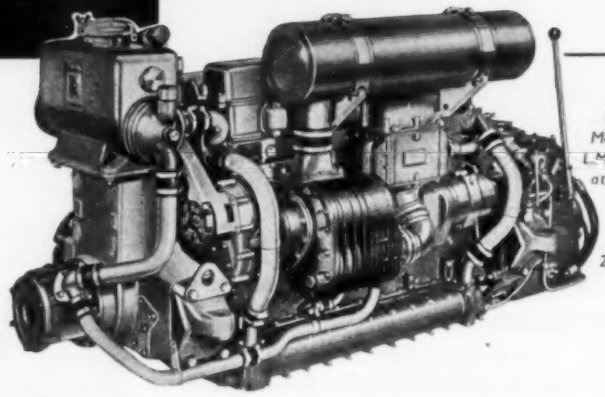
Under all conditions of load . . . penalties of straight oil operation . . . two high-altitude plant locations—close scrutiny of performance records of this year's winning plants clearly establishes the fact—you can't make a better buy than a Fairbanks-Morse Diesel or Dual Fuel Engine. Fairbanks, Morse & Co., Chicago 5, Ill.

*The Johnson plant also delivered top kw-h per BTU last year, but was eliminated from competition due to winning in two previous years

Model KMD 96 PENTA Diesel engine fitted with Godfrey K400 supercharger

POSITIVE DISPLACEMENT SUPERCHARGERS

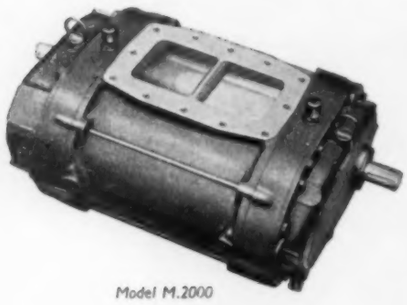
Simple, Compact, Easy to install, Comparatively low cost



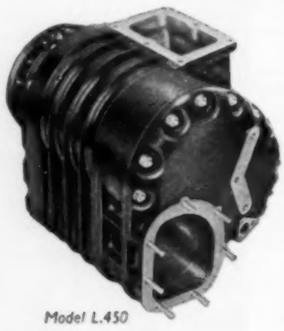
Rolls-Royce Model C6.S.F. L.M. 250b.h.p. at 2100 r.p.m. Marine Engine fitted with 2:1 Reverse Gearbox.

Specially developed for pressure charging and scavenging two and four stroke oil and petrol engines, Godfrey positive displacement superchargers are in world wide use. The units can be mounted in a variety of attitudes to suit installation requirements.

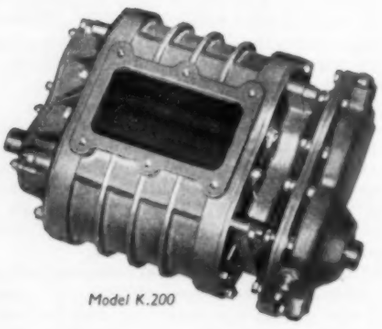
PERFORMANCE: *Single units air flows up to 3,500 cfm at pressures up to 10 psi*



Model M.2000



Model L.450



Model K.200

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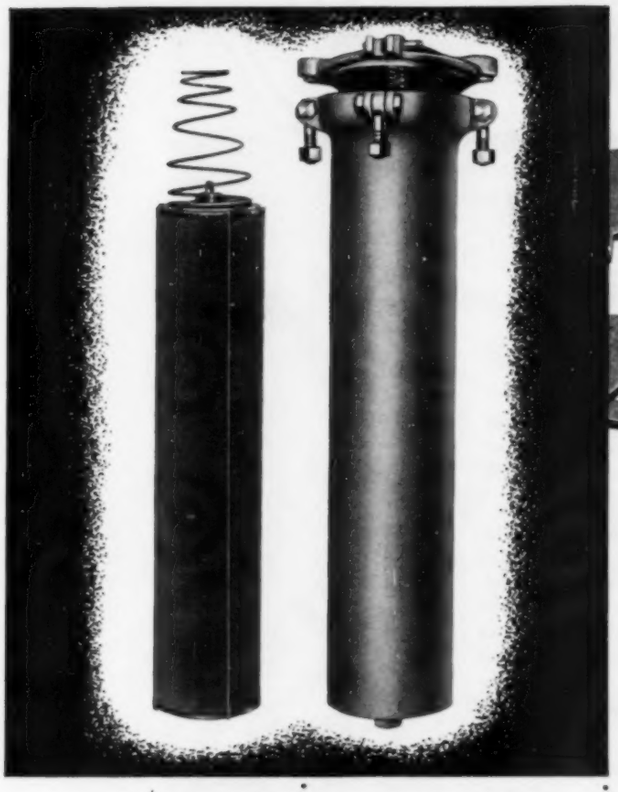
PROVIDE POSITIVE PROTECTION FOR DIESEL ENGINES WITH

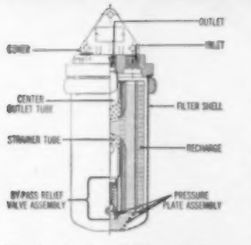
NUGENT LAMINATED DISC FULL FLOW LUBE OIL FILTERS



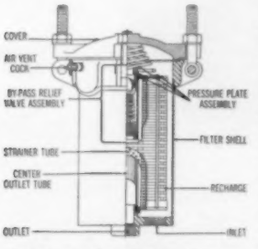
This "extended area" filter utilizes an actual filtering surface area greatly in excess of its container area. The Nugent Laminated Disc Filter provides a high flow rate at low pressure drop combined with the extreme fine filtering absorption and neutralizing properties of a depth type filter.

The filter charge consists of a stack of similar crenulated fiber discs, each rotated 45° from the position of the adjacent disc, thus affording proper channeling and maximum filtering capacity. Liquid passes from the exterior to the interior of the filter stack.

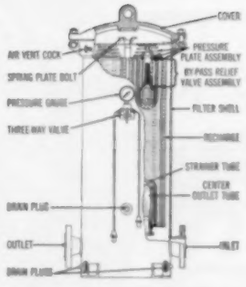
The filter recharge has a useful life of from 4 to 10 times that of a cellulose or waste recharge. Changing recharges requires only minutes. Cartridges are interchangeable with all other Nugent bag or depth type cartridges. Write for full details.



Body style of Fig. 1555, sizes 00, 0, 1R and 1S.



Body style of Fig. 1555, sizes 4S and 4L.

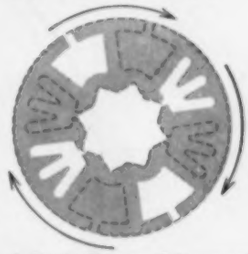


Body style of Fig. 1555, sizes 4L3, 4L4, 4L7 and 4L12.

DESIGN FEATURES

- Provides "Extended Area" filtering
- Removes solids as small as 2 microns
- Removes acid forming contaminants
- Will not remove additives
- Contains no chemicals or bleaches
- Working pressure 125 psi—tested to 375 psi
- High pressure filters to 600 psi—tested to 3000 psi
- Built in by-pass relief
- Maximum operating temperature 375° F.

HOW IT WORKS



Each disc in filter stack is rotated 45° from position of adjacent disc for proper channeling and maximum filtering capacity.

Established 1897

Wm. W. Nugent & Co., Inc.

3430 Cleveland Street Skokie, Illinois

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COOK SEGMENTAL RING No. 104

This ring of three or more segments provides a maximum seal for compressors. It is available in Cook Graphitic Iron, Cookmet Bronze, Carbon, and Phenolic material.

COOKTITE SEALING RING No. 109

Standard two-piece sealing ring made of Cook Graphitic Iron. Advantages include single-ring groove contact and dual-ring cylinder seal. Proven remedy for blow-by.

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Designed for ALL Sizes of Industrial Engines, Compressors and Hydraulic Equipment!

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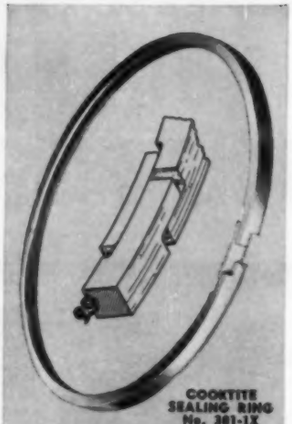

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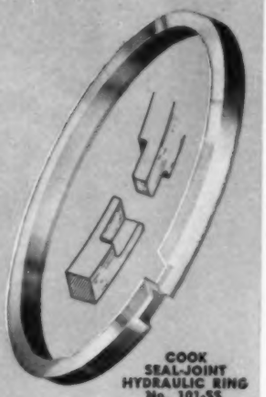
New, two-piece sealing ring made of Cook Graphitic Iron or Cookmet Bronze. Complete flexibility assures perfect wall contact at all times. No wearing period required.



COOK SEAL-JOINT HYDRAULIC RING No. 101-SS

Unique, single acting sealing ring for use in all grooves. Seal-joint construction provides unbroken sealing surfaces against both cylinder wall and groove land.

COOK SUPER-FLEX WIPER RING No. 303-DCX

One-piece conformable oil wiper ring made of Cook Graphitic Iron. Life-time coil spring provides uniform contact pressure. Wide channel and multiple notches assure direct flow to drain holes.

TOCCO® and the Diesel Industry Progress *Together*

• In the manufacture of many Diesel engine and accessory parts TOCCO Induction Heating has proved a sound method of increasing product quality, speeding production and lowering unit costs. TOCCO-hardening of vital parts prevents wear, insures 5 to 10 times longer life—with consequent customer satisfaction.

A Partial List of Manufacturers of Diesel Engines and Accessories Who Use TOCCO-Hardened Parts

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The Auto Car Co.
Buda Div., Allis-Chalmers Mfg. Co.
Caterpillar Tractor Co.
Cleveland Diesel Engine Div., GMC
Continental Motors Corp.
The Cooper-Bessemer Corp.
Cummins Engine Co., Inc.
Detroit Diesel Engine Div., GMC
Electro-Motive Division, GMC
Hercules Motors Corp.
International Harvester Co.
Baldwin-Lima-Hamilton Corp.
White Diesel Engine Div., The White Motor Co.
Waukesha Motor Co.
Eaton Manufacturing Company
Link-Belt Company
Worthington Corp.
Thompson Products Company

And These Are Some of the TOCCO-Hardened Parts They Use

Crankshafts
Camshafts
Axle Shafts
Piston Pins
Shifter Rods
Adjusting Screws
Cylinder Liners
Rocker Arms
Cam Followers
Valves
Rocker Arm Shifts
Timing Gears
Shifter Forks
Transmission Gears
Final Drive Gears
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Universal Joint Assemblies

TOCCO Engineers can probably find applications in your plant, too, where TOCCO Induction Heating can improve product quality, increase production and lower costs. Such a survey costs you nothing and may save you a great deal.

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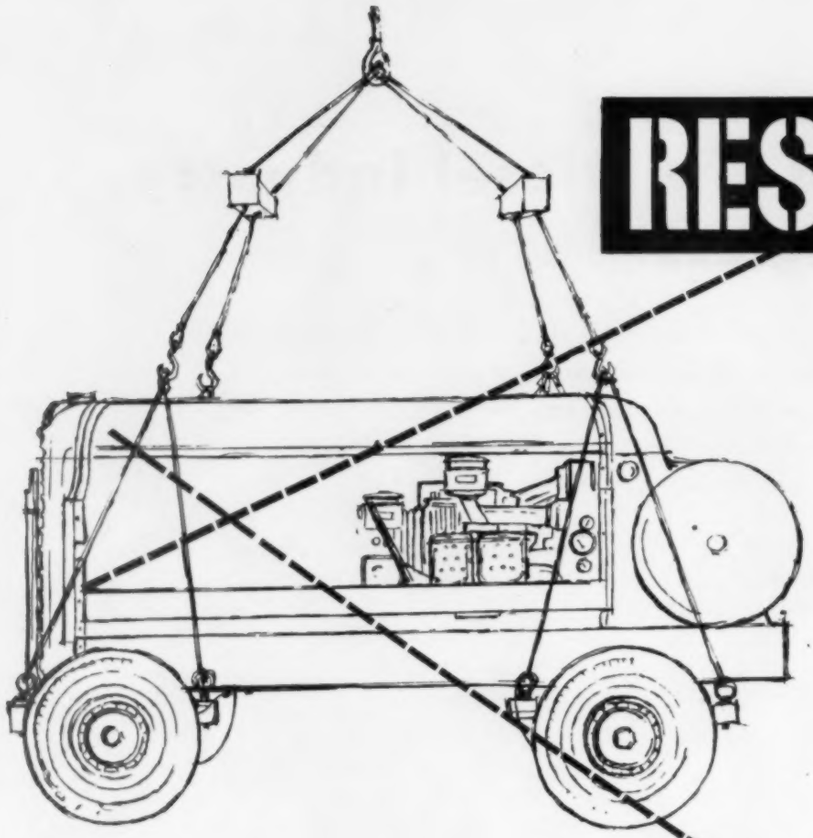

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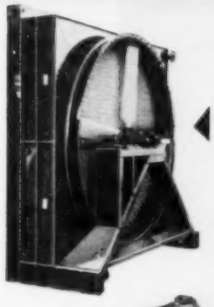

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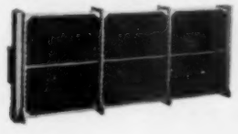
Free-flow type—a Young industrial design. Rugged units built for heavy-duty cooling in field or industrial service. Young original Mono-Weld construction is lightweight, assuring longer life, trouble-free operation.

Radiators for Diesel, Gas and Gas Turbine Locomotives

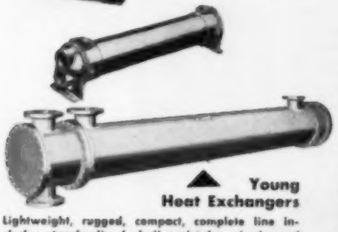
Heavy-duty, rugged units are built integrally or in sections . . . for top, side or front mounting as required.



Young Cooling and Condensing Units — Manufactured in single units or batteries for handling large capacity cooling requirements . . . gas, oil, water. Rugged structural design, units are available with a wide choice of cores for all applications. Complete with fans, power plants and controls.

Intercoolers

High or low pressure types available for cooling all types of compressors, and super-charged engines—gas, gasoline, Diesel and marine Diesel.



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Lightweight, rugged, compact, complete line includes standardized shell-and-tube, single and multi-pass, fixed and removable tube bundle units. Units available for any heat transfer application.

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Combine vertical air discharge with space saving design—means extra large capacity. Used for water, oil, gas cooling . . . steam, vapor condensing . . . almost any combination of cooling or condensing services. Vertically mounted coils . . . multi-fans . . . rolling doors over core faces . . . coils available in variety of standard tube sizes and lengths.

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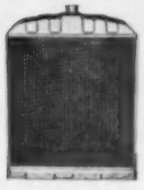
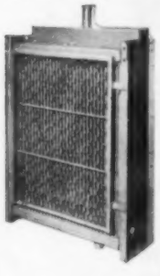
Young Heat Exchanger

Type "OH" oil to air cooling units are used for reclaimed heat or where water supply is critical.



Stamped Tank Metal Radiators

Specially designed for trucks, tractors, combines, power units, gas and Diesel automotive and prime mover installations.



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Young specially designed integral structure for rugged requirements. This radiator is used in heavy industrial applications for cooling oil and jacket water.

Cast Tank Radiators

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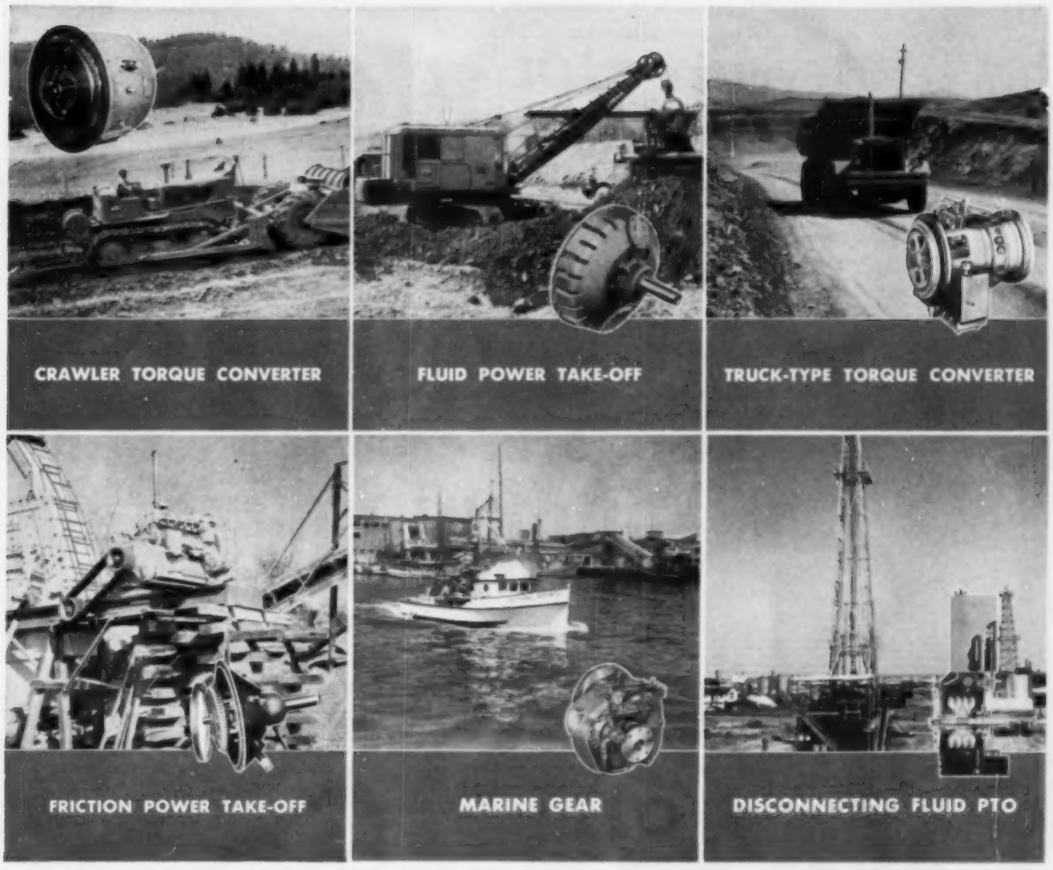

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In industry today—wherever *diesel* power is applied to driven equipment — you find Twin Disc Friction Clutches or Fluid Drives.

In construction, mining, quarrying and logging, you'll find the biggest crawler tractors driving through Twin Disc Torque Converters . . . power shovels, equipped with either Twin Disc Converters or Fluid Power Take-Offs . . . trucks incorporating Twin Disc Truck-Type Torque Converters . . . and stationary power units, equipped with heavy-duty Twin Disc Friction Power Take-Offs.

In the oil fields—*throughout the world*—you'll find diesel engines, on drilling rigs, driving through Twin Disc Torque Converters or Model HUD Disconnecting Fluid Power Take-Offs.

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If *you* have a power transmission problem — consult the Twin Disc Clutch Company, Racine, Wis., Hydraulic Division, Rockford, Ill.

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your

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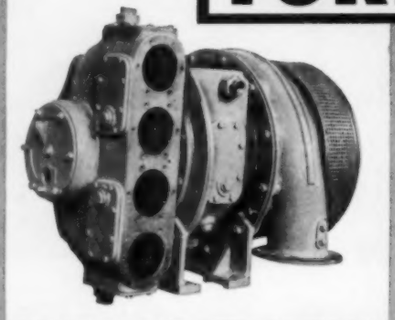
is more efficient

when it is equipped with a

BROWN BOVERI

exhaust gas

TURBO-CHARGER



A Brown Boveri Turbo-Charger on your diesel engine is an investment in more efficient operation, in lower maintenance, in longer life.

The advantages of these compact turbo-chargers, listed at the right, are confirmed by the experiences of hundreds of diesel engine plants throughout the world under all types of climatic and atmospheric conditions.

You owe it to yourself to get the complete facts about this equipment. *Write for the descriptive data today.*

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- Continuous power increases of 100% and more.
- No increase in operating costs since chargers run on exhaust gases from turbines.
- 40% and more reduction in space and weight per H. P. of supercharged engine.
- Self-contained lubricating system eliminates special oil piping outside the engine.
- Air pressure equalization prevents pollution of blower wheel and bearings.
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Available in various sizes for charged outputs from about 100 B.H.P. to 6,000 B.H.P.

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BROWN BOVERI CORPORATION

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set the standards of dependability for continuous service at full capacity

200 to 380 hp Type "TS"

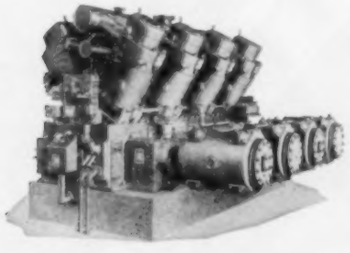
With the Ingersoll-Rand "TS" Diesel, you get big-engine performance in a small package. The "TS" is a modern speed, continuous service engine . . . with all the features essential to long life that are usually found only in much larger engines. The "TS" is a four-cycle, single-acting, solid-injection engine of the fully enclosed type and is equipped with a complete pressure lubrication system, wet liners and many other "big engine" features.

The TS has a bore of 7 inches and a stroke of 8¼ inches. It is built in three models: a 6 cylinder naturally aspirated unit rated 200 hp at 900 rpm or 220 hp at 1000 rpm: a 6 cylinder supercharged engine rated 260 hp at 900 rpm or 285 hp at 1000 rpm: and an 8 cylinder supercharged model rated 345 hp at 900 rpm or 380 hp at 1000 rpm.

375 to 1000 hp Type "S" and "SS"

With the "S" and "SS" Diesels, Ingersoll-Rand makes available all of the advantages of modern diesel engineering – in a line of engines that is unequalled in year-after-year economy and dependability under continuous heavy-duty service.

Built with 5, 6, 7 and 8 cylinders, "S" and "SS" engines have a bore of 10½ inches and a stroke of 12 inches. They are fully enclosed, solid-injection, single-acting units that operate on the 4-stroke cycle. The Type "S" is naturally-aspirated and rated at 375, 450, 525 and 600 hp. "SS" units are supercharged and rated at 570, 715, 785 and 900 hp. With intercooling of the charging air "SS" engines will develop 600, 750, 875 and 1000 hp. Both the "S" and "SS" engines operate at 720 rpm for 60-cycle service and 750 rpm for 50-cycle service.



SVO Diesel-Engine Compressor

5 sizes . . . capacities from 1065 to 3200 cfm at 100 psi

The SVO is a heavy-duty machine which combines a 4-cycle V-angle Diesel engine and a double-acting compressor in a single frame. It is designed for economy and dependability in continuous service either at full or part loads. It is easy to install, operate and maintain.

Built in five sizes, the SVO can be furnished with 12-inch-stroke compressor cylinders to handle air or gas at any pressure or vacuum. Its compactness and operating economy make it an ideal compressor for a wide range of installations.

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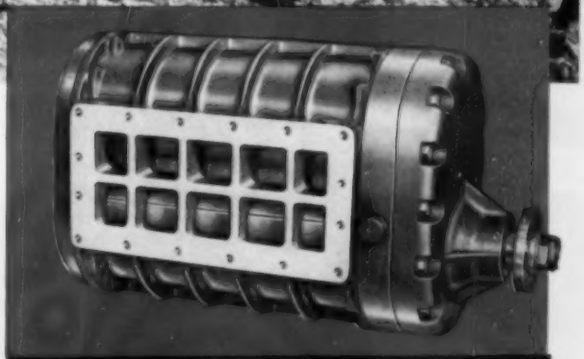
GIANT HD-21 CRAWLER DOZES with Supercharged Power!



ALLIS-CHALMERS STANDARDIZES ON MIEHLE-DEXTER SUPERCHARGERS FOR THEIR DIESEL ENGINES

Like so many leading Diesel engine manufacturers, Allis-Chalmers specifies Miehle-Dexter Superchargers for their engines.

And that's one of the reasons this new giant torque converter driven crawler tractor—the Allis-Chalmers Model HD-21—claims to be one of the most powerful crawlers . . . anywhere! Rough and rugged dozing needs power aplenty. And here's *extra* speed at any load, *extra* pushing or pulling power at any speed, wider speed range and more range overlap—thanks to Miehle-Dexter Supercharged Power.

You, too, can boost the horsepower of your engines by 50% or more . . . and decrease weight per horsepower, too. Miehle-Dexter engineers can specify the exact size and type M-D supercharger for your engines. Standard M-D models available for applications to 750 hp. Write for bulletin.

FOUR FEATURES PROVE MIEHLE-DEXTER SUPERCHARGERS BETTER ON THE JOB

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- Rotor wear strips eliminate contact between rotors and housing, assure longer wear.
- Lightweight aluminum rotors and aluminum case boost engine horsepower, do not add weight, safely allow high speeds.
- All parts are standardized, allowing easy field service and interchangeability.

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AN ENTIRELY *NEW* TYPE
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Supercharger Division of The Christensen Machine Co.
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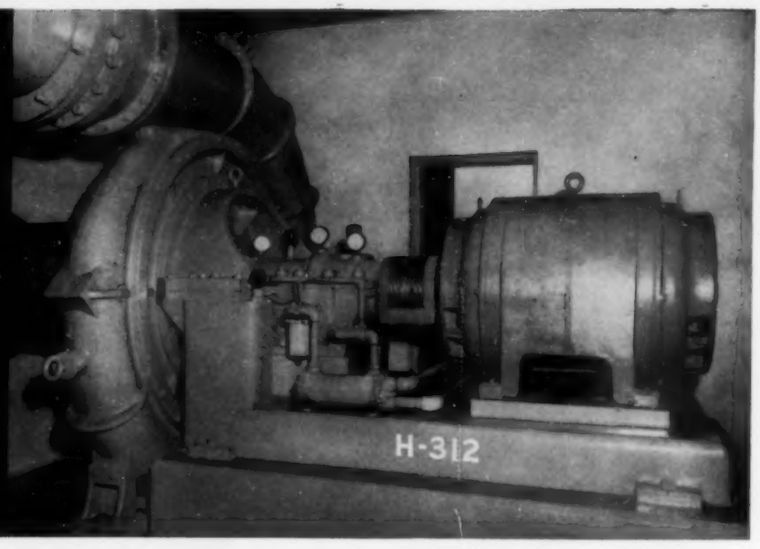

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Choice between Centrifugals and Rotary Positives

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Adaptable to high-speed, direct connected drives

Low maintenance, high efficiency, long-time dependability

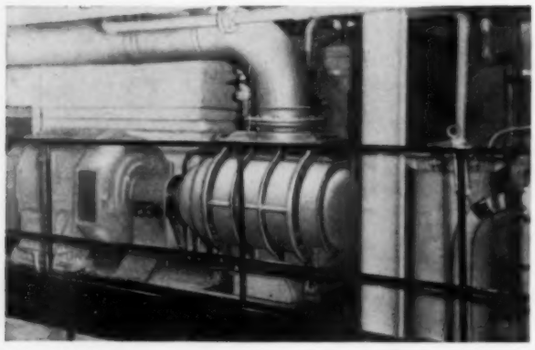
Strict adherence to these four basic essentials, in both design and construction, has made R-C Blowers the outstanding choice of leading builders of diesel engines. Their judgement has been confirmed by successful experience of their thousands of customers.

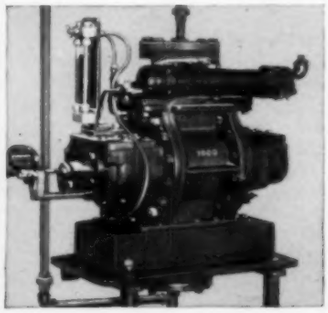
Roots-Connersville is the only manufacturer that gives you the *dual-choice* between Rotary Positive and Centrifugal equipment, in a wide range of capacities. Thus you can match blower to engine at minimum cost and maximum efficiency. The heavy, rugged construction of R-C Blowers enhances their smooth performance, resulting in installations that substantially reduce the annoyances and wear caused by excessive vibration and noise.

You can select the right R-C Blower to match your drives... whether gas, oil or turbine. Their small size per cubic foot of capacity makes for a more compact installation, whether built-in or detached. This results in lower first cost for space and installation.

Where meters are needed for natural gas or dual-fuel types of engines, Roots Positive Displacement Meters give long-time accuracy, because of simple design and absence of small parts to wear out or need maintenance. Capacities are available to match every need.

For your new diesels or to obtain better performance from present equipment, we suggest that you ask Roots-Connersville to prove the values of these Big-4 essentials, built into every R-C unit.

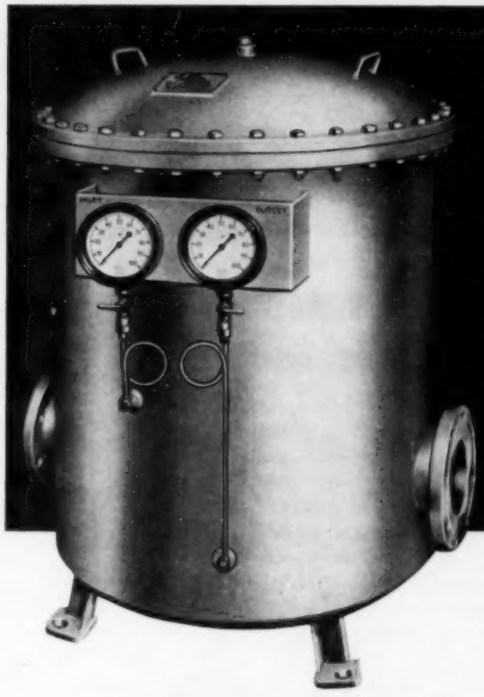


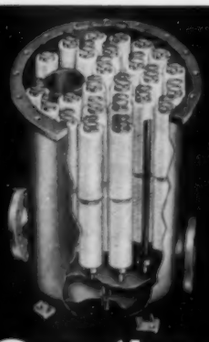


ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC. · 157 EASTERN AVENUE, CONNERSVILLE, INDIANA

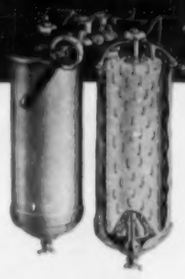
25 Sales Offices at your service: BIRMINGHAM • BOSTON • BUFFALO • CHATTANOOGA • CHICAGO • CLEVELAND • DALLAS • DENVER • DETROIT HOUSTON • JOHNSON CITY, TENN. • KANSAS CITY, MO. • LOS ANGELES • NEW ORLEANS • NEW YORK • PHILADELPHIA • PHOENIX PITTSBURGH • PORTLAND, ORE. • ST. LOUIS • SALT LAKE CITY • SAN FRANCISCO • TORONTO, ONT. • TULSA • WASHINGTON, D. C.





Fulflo FILTERS PROVIDE...

Continuous Micronic Clarity of fuel and lubricating oils



Fulflo Filters give you the exact degree of continuous micronic clarity you need for both fuel and lubricating oils.

WIDE APPLICATION: Fulflo Filters are designed for all types and sizes of stationary engines, mobile equipment, and for bulk filtration. They are applicable to both the pressure and suction sections of fuel lines.

EXCLUSIVE HONEYCOMB FILTER TUBES: An exclusive advantage of Fulflo Filters is the Honeycomb Filter Tube which is manufactured in a wide range of positively controlled densities. You get true *depth* filtration. Impurities are accumulated in hundreds of inner cells instead of building up on the outside surfaces. Honeycomb Filter Tubes are inexpensive and easily replaced. They do *not* remove oil additives.

HIGH OR LOW FLOW RATES: Fulflo is available in a wide variety of sizes. Standard models are designed for all normal operating conditions. Special models handle flow rates as high as 2000 gpm.

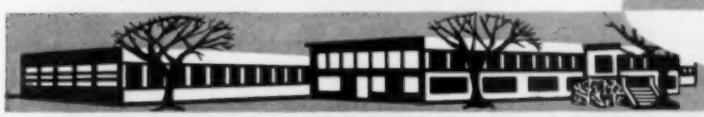
ENGINEERED TO YOUR NEEDS: Whatever your operating conditions, Fulflo Filters are engineered to your exact requirements. Where desired, they can be made an integral part of your equipment.

CFC FILTERS EMPLOY INTERCHANGEABLE CARTRIDGES

CFC Oil Filters (including former Honan-Crane models) employ a variety of filter media for removal of soluble as well as solid impurities. Multi-Cartridge Filter (illustrated) provides a choice of six types of interchangeable cartridges depending on type and degree of filtration desired. Available in ten sizes using one to twenty-four cartridges. CFC Bulk Refill model, also available, operates on by-pass or continuous recirculation basis. CFC Michiana Filters with "throw-away" or repackable elements provide especially low-cost filtration.

For technical literature, write Department DC.

Micro-Fine Filtration for Low Cost Clarity



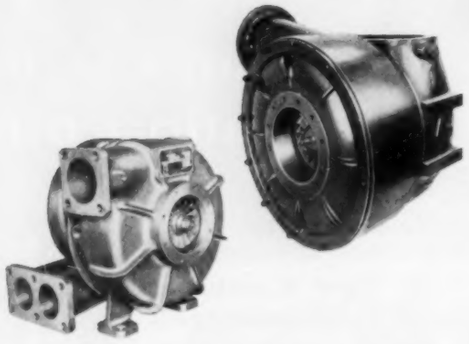
COMMERCIAL FILTERS CORPORATION

MELROSE 76, MASSACHUSETTS

Plants in Melrose, Massachusetts and Lebanon, Indiana

FULFLO FILTERS WITH GENUINE HONEYCOMB FILTER TUBES FOR CONTROLLED MICRONIC CLARITY • CFC MULTI-CARTRIDGE OIL FILTERS
PURIVAC INSULATING OIL CONDITIONERS • DRI-PURE WATER-OIL SEPARATORS • PRE-COAT FILTERS • MAGNETIC SEPARATORS
AUTOMATIC TUBULAR CONVEYORS • COOLANT CLARIFIERS

More power to diesels ELLIOTT More power from diesels

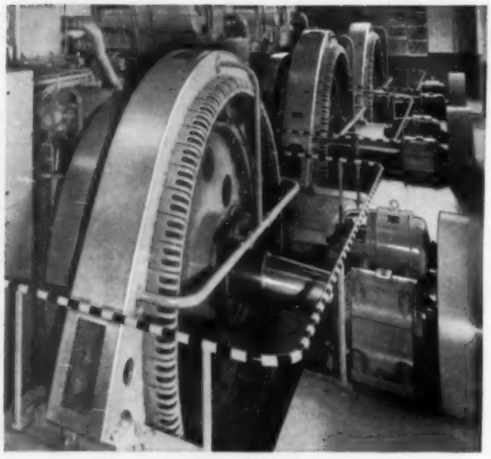


TURBOCHARGERS that deliver all the pressure any diesel can use

Elliott high pressure turbochargers send air to the cylinders at up to 30 psi, meeting every supercharging need of high pressure engine design... increasing engine output up to 100%... increasing overload capacity... enabling constant torque at reduced speeds... reducing consumption of fuel and lube oil.

All this without taking toll of engine power, because exhaust gas from the engine does the work, with the added advantage of automatically adapting turbocharger speed to engine speed, and leaving turbocharger operation unaffected by reversing engine.

Now available for 4 cycle and 2 cycle Diesels.

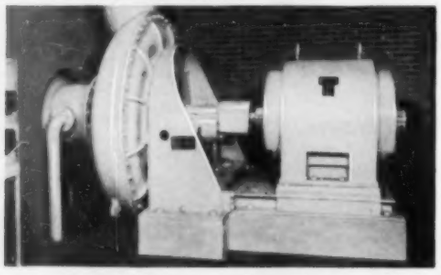


GENERATORS individually designed to the diesels that drive them

Elliott "Fabri-Steel" construction lends itself to the utmost design flexibility in adapting generators to particular installations and specific engines, while providing the further advantages of crack-proof strength and endurance with the extreme rigidity of expertly fabricated steel. Elliott generators for diesels are built in vertical as well as horizontal types. Their country-wide reputation for dependability is attested by numerous cases of reorders whenever additions are made to a plant originally equipped with Elliott generators. Thousands of these generators, driven by all makes of diesels, are quietly spinning off the kilowatts, serving in every state of the Union.

SCAVENGING BLOWERS

Single-stage blowers, direct-connected or geared to Elliott motors. Substantial, rigid construction throughout practically eliminates vibration. Available in capacities of 5000 cfm and upwards.

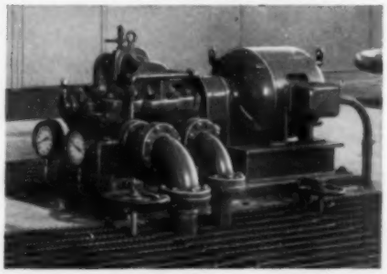


STRAINERS

for oil or water. Twin strainers supply their own standby service, without interruption for cleaning. Single strainers where occasional stop for cleaning is permissible.

ELLIOTT C-W MOTORS for pump drives

With the famous Crocker-Wheeler name linked to Elliott, these motors can be depended upon for all types of service in and around diesel plants. The motor in the illustration is 20 hp, 1760 rpm.



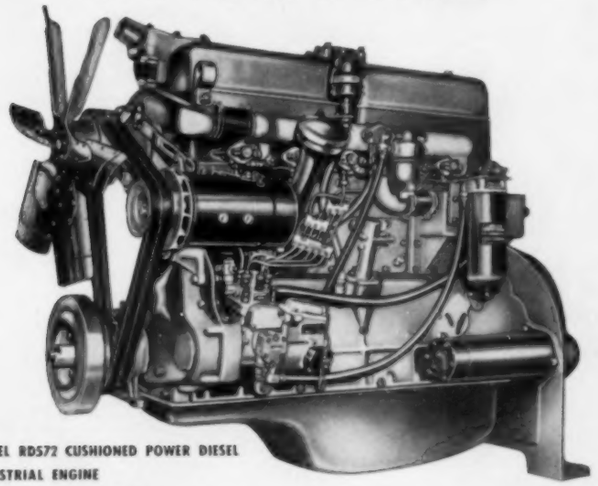
For full data on the above products, contact your nearby Elliott district office or representative or write

ELLIOTT Company, Jeannette, Pa. DISTRICT OFFICES AND DISTRIBUTORS IN PRINCIPAL CITIES

CONTINENTAL

® CUSHIONED POWER DIESELS

34 to 225 HORSEPOWER



MODEL RDS72 CUSHIONED POWER DIESEL
INDUSTRIAL ENGINE
154 H. P. @ 2000 R. P. M.

There are three main reasons why Continental's Cushioned Power principle results in higher performance and more efficient operation.

1. Combustion chamber design assures higher turbulence, promotes cleaner burning. All fuel is utilized.

•

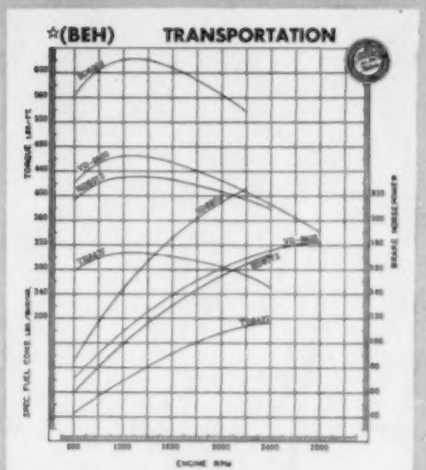
2. Operation is smoother. Cushioning of the explosive force results in reduction of noise.

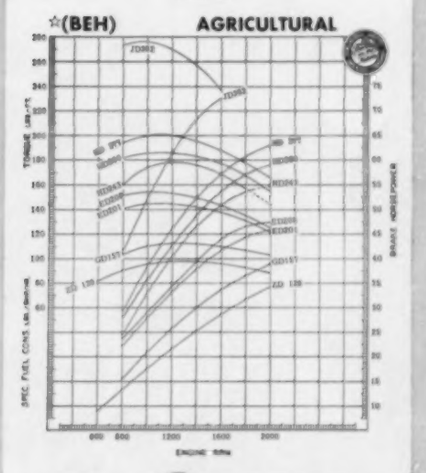
•

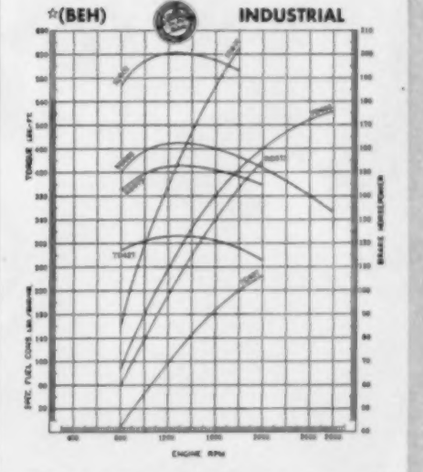
3. Easing of peak forces on rods, shafts, and bearings makes for longer service, with less time out for repairs. By permitting wide interchangeability of parts with Red Seal® gasoline models, it greatly simplifies the job of service in the field.

Continental Cushioned Power Diesels are now available for various applications in transportation, agriculture and industry. Write for bulletins and color folder showing how Cushioned Power works.

PARTS AND SERVICE COAST TO COAST







☆(BEH) BARE ENGINE HORSEPOWER ZD, JD, HD AND ED MODELS FOR INDUSTRIAL APPLICATIONS ONLY.

CONTINENTAL MOTORS ® Powerful as the Nation AMERICA'S STANDARD

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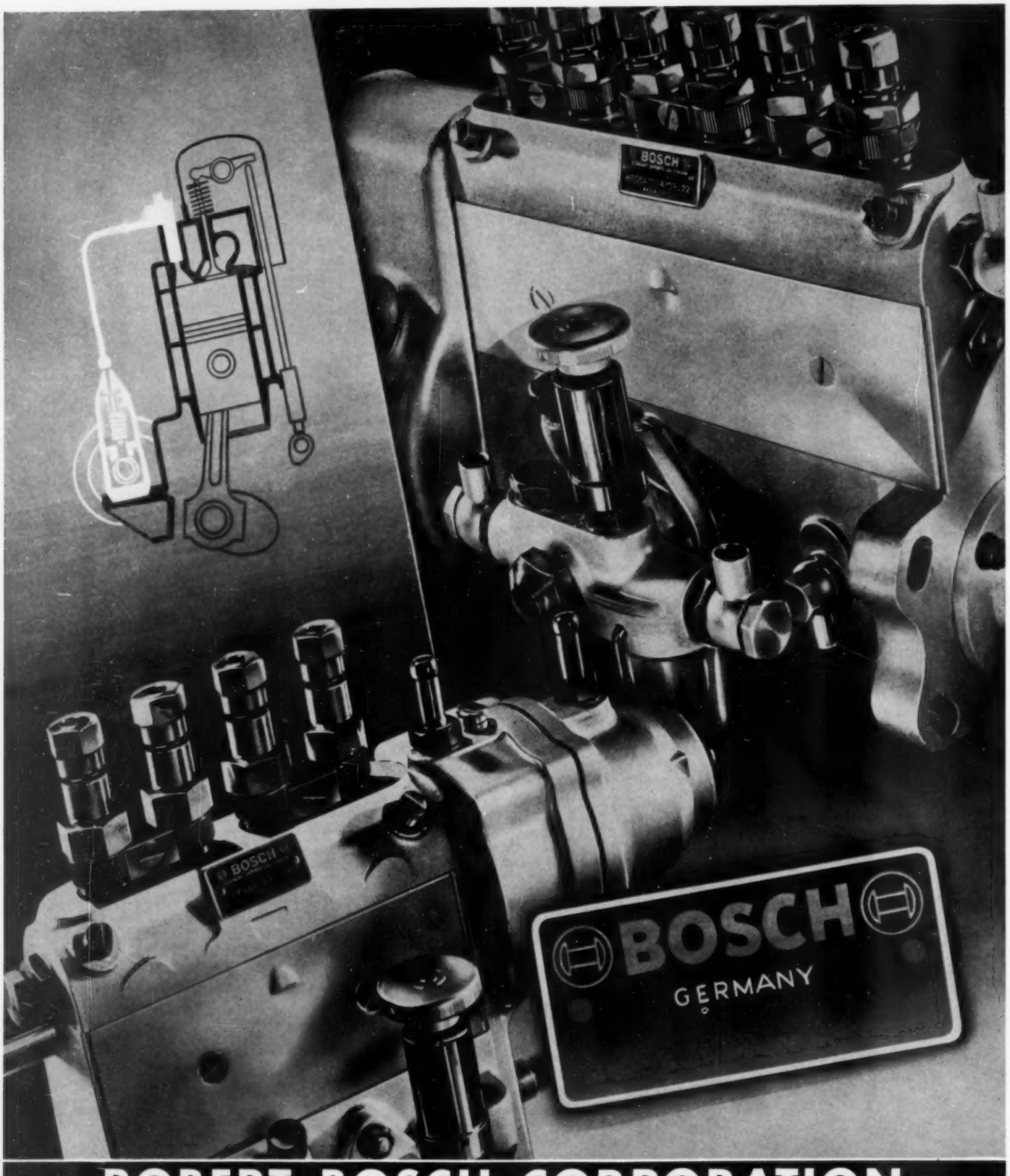
3817 SOUTH SANTA FE AVENUE, LOS ANGELES 58, CALIFORNIA • 1252 OAKLEIGH DRIVE, EAST POINT (ATLANTA) GEORGIA



ROBERT BOSCH CORPORATION

268 Fourth Avenue, New York 10, N. Y. • 225 Seventh Street, San Francisco 3, Cal.

Robert Bosch (Canada) Ltd., 5767 Monkland Ave., Montreal 28, Que.
Sales and Service Representatives for

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a problem of supercharging?

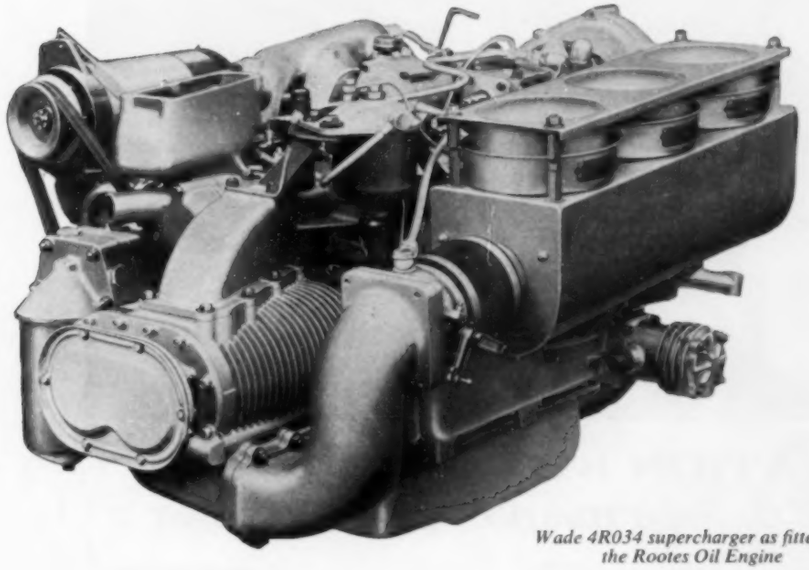
You, as a designer, are of course well aware of the basic problems connected with a decision to supercharge an oil engine—

Increasing fuel costs which compel the choice of a unit requiring the minimum of horse power to drive it.

The necessity for the supercharger to be trouble free, reasonably quiet in operation and capable of long service.

The oil seal difficulties created by the vacuum-governing factor which have to be overcome so that pressures and vacuums can be increased without loss of efficiency.

The absolute requirement that the supercharger can be produced at an economic price, and delivered to a schedule.



Wade 4R034 supercharger as fitted on the Rootes Oil Engine

Specialists in this field, as a result of long research and development, we claim that the WADE supercharger cannot be surpassed for :

MAXIMUM OVERALL EFFICIENCY UNDER ALL CONDITIONS

MINIMUM OF NOISE IN OPERATION

TROUBLE FREE OPERATION AND LONG LIFE

at an economic cost.

We have a wealth of technical knowledge at your disposal on any thermodynamic problem related to superchargers.

We have designed a supercharger to meet your problems.

We have a factory laid out and equipped for the sole purpose of producing superchargers on a really economic basis.

Moreover we CAN produce them at an economic price and to a schedule.

WADE ENGINEERING LIMITED
CROWHURST ROAD, BRIGHTON, 6
ENGLAND. BRIGHTON 59277-8-9
TELEGRAMS: BLOWERS BRIGHTON

May we place our knowledge, experience and facilities at your disposal? We shall be very pleased to discuss — without obligation — any present or future application for Roots-type superchargers or Turbo superchargers.

WADE

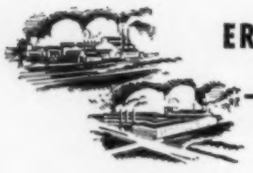
SPECIALISTS IN ROOTS-TYPE SUPERCHARGERS

SPECIFICATION STEEL ...
For the Unseen Heart of a Giant Diesel

Close control from engineering design to selecting raw materials, melting, forging, heat treating, finish and testing . . . the finished product, a 46,400 pound one piece, 12 throw crankshaft which proves its quality at the heart of the Diesel.

This 72 inch ingot, weighing 210,000 pounds, demonstrates the capabilities offered to you at Erie Forge & Steel Corporation. Here is the utmost in steel making skill . . . tough, rugged, innate quality necessary to stand the stresses to which the world's biggest one piece crankshaft will be subjected in operation . . . quality that assures the desired performance.

The Erie Forge & Steel Research and Development program is charged with the responsibility of making ingots so good that hot forging and heat treating operations produce a finished product which easily meets the requirements of the user. Your steel forgings and castings are produced here under One Responsibility and One Control. Place your requirements with us, fully confident of the desired results.



ERIE FORGE & STEEL CORPORATION

ERIE, PENNSYLVANIA

MEMBER AMERICAN IRON AND STEEL INSTITUTE

ERIE FORGE & STEEL CORPORATION

WAUKESHA

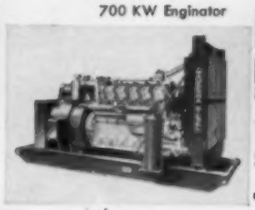
ENGINES and POWER UNITS—10 hp.-1135 hp.

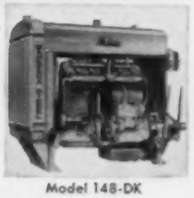
Normal and Turbocharged Diesels, Gasoline, Natural Gas, LPG ···
Standard or Counterbalanced Crankshafts

WAUKESHA MOTOR COMPANY, Waukesha, Wis. • New York, Tulsa, Los Angeles

Model VLRDBS

700 KW Enginator

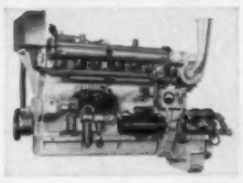




Model 148-DK

Model WAKDBS

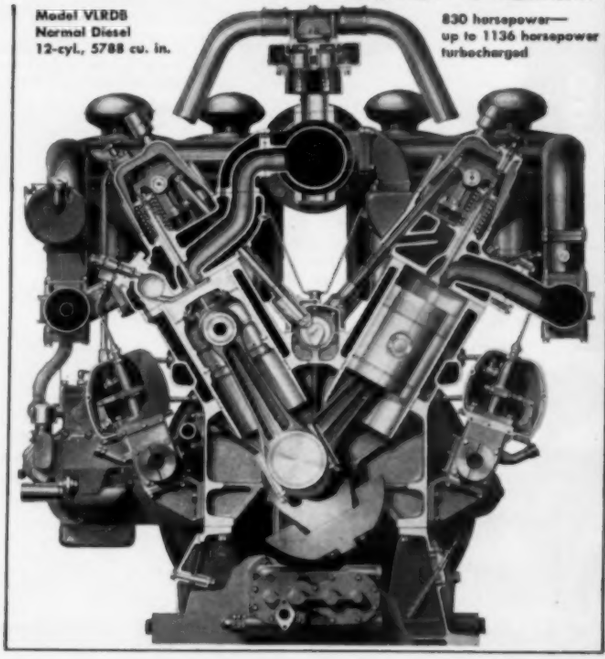
WAKDBM Marine Diesel



Model 135-DKBS

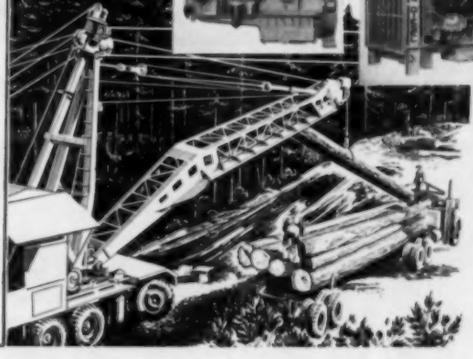
Model VLRDB
Normal Diesel
12-cyl., 5788 cu. in.

830 horsepower—
up to 1136 horsepower
turbocharged



Model WAKD

Model WAKDBSU



341

130 to 2000 HORSE POWER

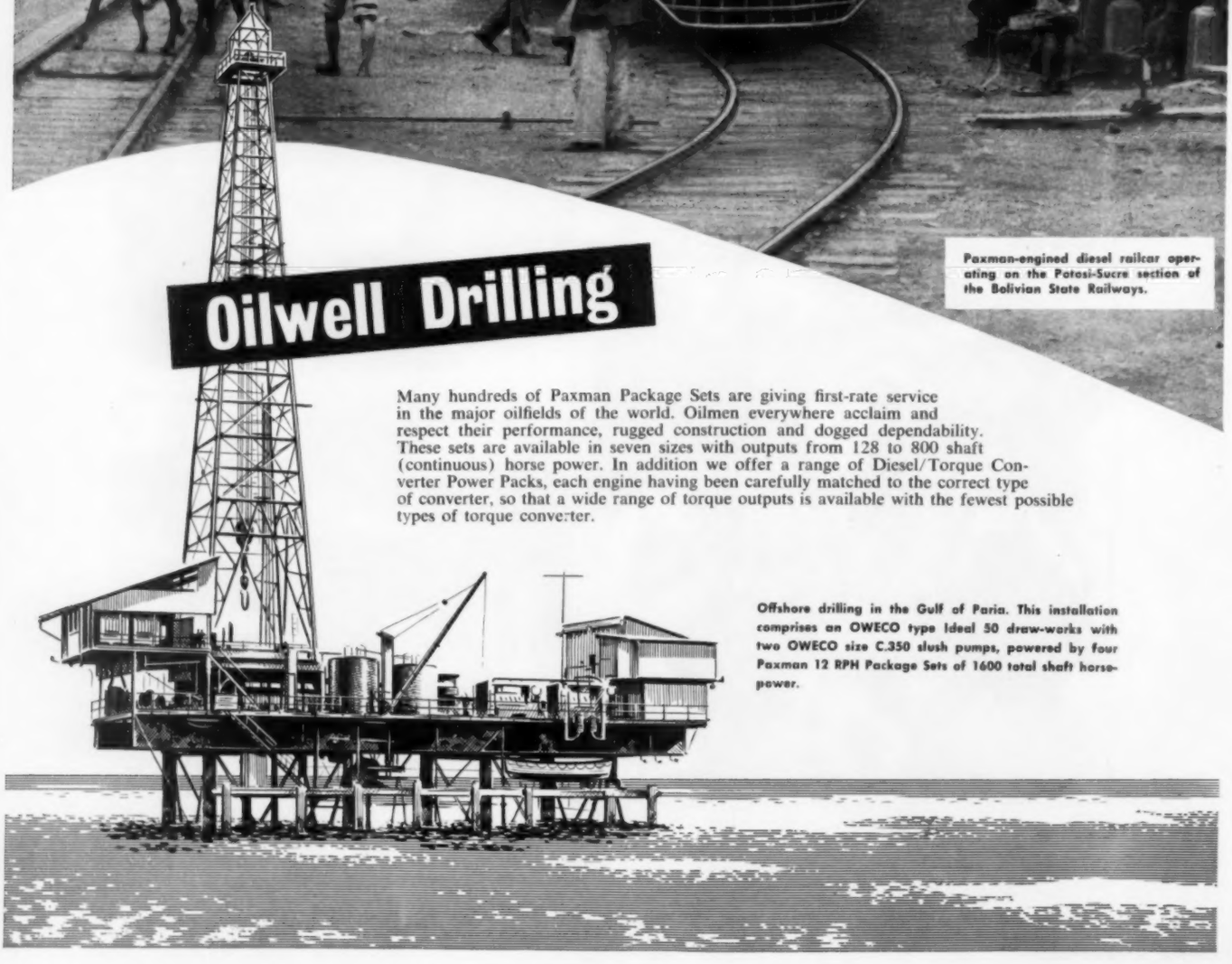
Rail Traction

Twenty-five years ago a 412 b.h.p. Paxman engine was installed in the first diesel locomotive ever built by a British railway. Since then we have actively pursued a policy of designing power units to meet railway traction requirements. How well these units have performed under arduous service conditions is proved by the fact that Paxman engines for diesel mechanical, diesel hydraulic and diesel electric transmission, totalling 150,000 b.h.p., have been supplied to railways all over the world. The present range covers vee-form units for shunting, mixed traffic and passenger locomotives and flat engines for railcar duty.

Paxman-engined diesel railcar operating on the Potosi-Sucre section of the Bolivian State Railways.

Oilwell Drilling

Many hundreds of Paxman Package Sets are giving first-rate service in the major oilfields of the world. Oilmen everywhere acclaim and respect their performance, rugged construction and dogged dependability. These sets are available in seven sizes with outputs from 128 to 800 shaft (continuous) horse power. In addition we offer a range of Diesel/Torque Converter Power Packs, each engine having been carefully matched to the correct type of converter, so that a wide range of torque outputs is available with the fewest possible types of torque converter.



Offshore drilling in the Gulf of Paria. This installation comprises an OWECO type Ideal 50 draw-works with two OWECO size C.350 slush pumps, powered by four Paxman 12 RPH Package Sets of 1600 total shaft horsepower.

IN TWO CYLINDER SIZES

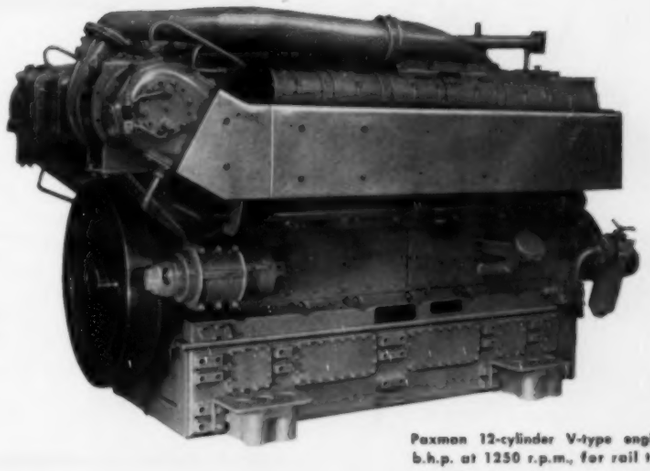
with maximum interchangeability of wearing parts

The two ranges of Paxman diesel engines, 7" bore, 130-1,000 b.h.p. and 9¾" bore, 533-2,000 b.h.p., are more compact and lighter for horse-power within these ranges than those of any other manufacture. Careful thought in design has ensured a high degree of interchangeability of wearing parts in each of these ranges, thus reducing maintenance costs and spares storage space to the minimum.

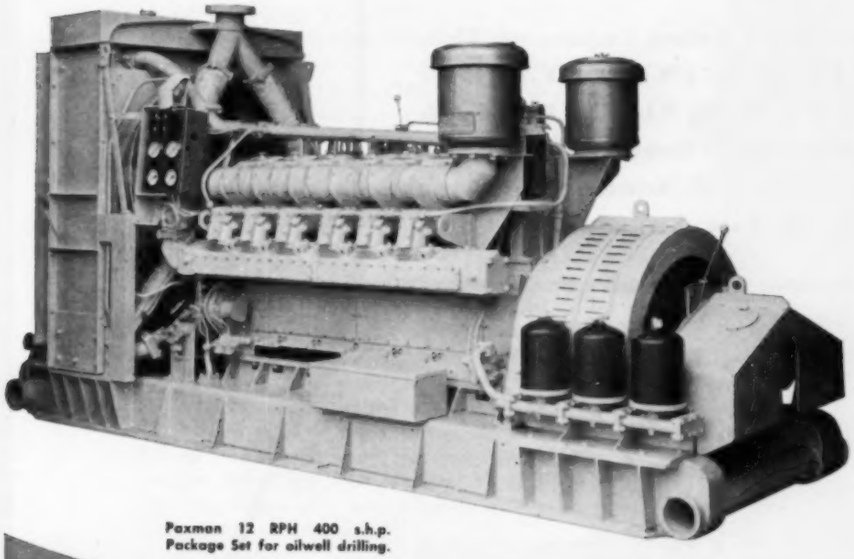
These engines are the outcome of over ninety years experience in the design and production of prime movers and have a long history of sound performance in numerous fields of application, in which they have earned a reputation for efficiency and reliability. The current types are built in cast iron, fabricated steel and light alloy and in normally-aspirated and pressure-charged form.

Whilst much has been done in the design of Paxman engines to obviate the necessity of renewing parts, the life of any engine must always depend on the quality of maintenance received at site.

Whilst our spares organisation is up-to-the-minute, operators of Paxman engines have at their disposal a world-wide network on which they can call for advice and for the services of fully qualified Diesel Engineers. In addition, our own engineers at home regularly visit territories gaining knowledge of the operation of the engines under varying conditions and at the same time giving advice on the best methods of overcoming site difficulties.



Paxman 12-cylinder V-type engine. 500 b.h.p. at 1250 r.p.m., for rail traction.



Paxman 12 RPH 400 s.h.p. Package Set for oilwell drilling.

In addition to diesel engines Paxman products include Boilers for power generation, industrial processing and space heating and Rotary Vacuum Filters for the coal, chemical, paper, mining, food and textile industries. We are on Lloyd's List for Class A.1. Welding and fabricate large components for industry, including refinery tanks and towers, chemical plant and engine frames and components.

PAXMAN

DIESEL ENGINES FOR RAIL TRACTION, OIL WELL DRILLING INDUSTRIAL AND MARINE APPLICATIONS

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3 dependable products for the diesel industry

DE LAVAL IMO PUMPS

De Laval IMO pumps do a dependable job during long years of service. The reason is IMO design simplicity. De Laval IMO's have only three moving parts—smoothly intermeshing rotors that propel the fluid axially in a steady flow without churning, pocketing or pulsation. There are no reciprocating parts to wear or become noisy. Quiet, compact IMO pumps are excellent for direct-connected, high-speed operation. They can be furnished in capacities to 1,000 gpm and pressures to 1,500 psig.

DE LAVAL HYDRAULIC FAN DRIVES

De Laval Hydraulic Fan Drives for air cooled heat exchangers and cooling towers offer these important advantages. They *save* power since the fan operates at full speed only a portion of the time. They provide *accurate, automatic* control of engine jacket water temperature, and also assure complete operational flexibility. These units stay on the job for years. As shown, both IMO motor and speed reducer are mounted and factory aligned on a single bedplate.

DE LAVAL HIGH PRESSURE TURBOCHARGERS

De Laval turbochargers offer pressure ratios of 3:1 as well as higher compressor and turbine efficiencies than those found in conventional turbocharger systems. Output of heavy duty diesel, gas and dual-fuel engines may be doubled by De Laval turbochargers without increasing thermal loading. Exclusive Monorotor design offers a compact lightweight unit of sturdy construction. De Laval turbochargers are self-adjusting to engine loads, can be used on 4- *and* 2-cycle engines.

You'll find additional data in these De Laval Bulletins. Write for your copies.

DE LAVAL

Steam Turbine Company

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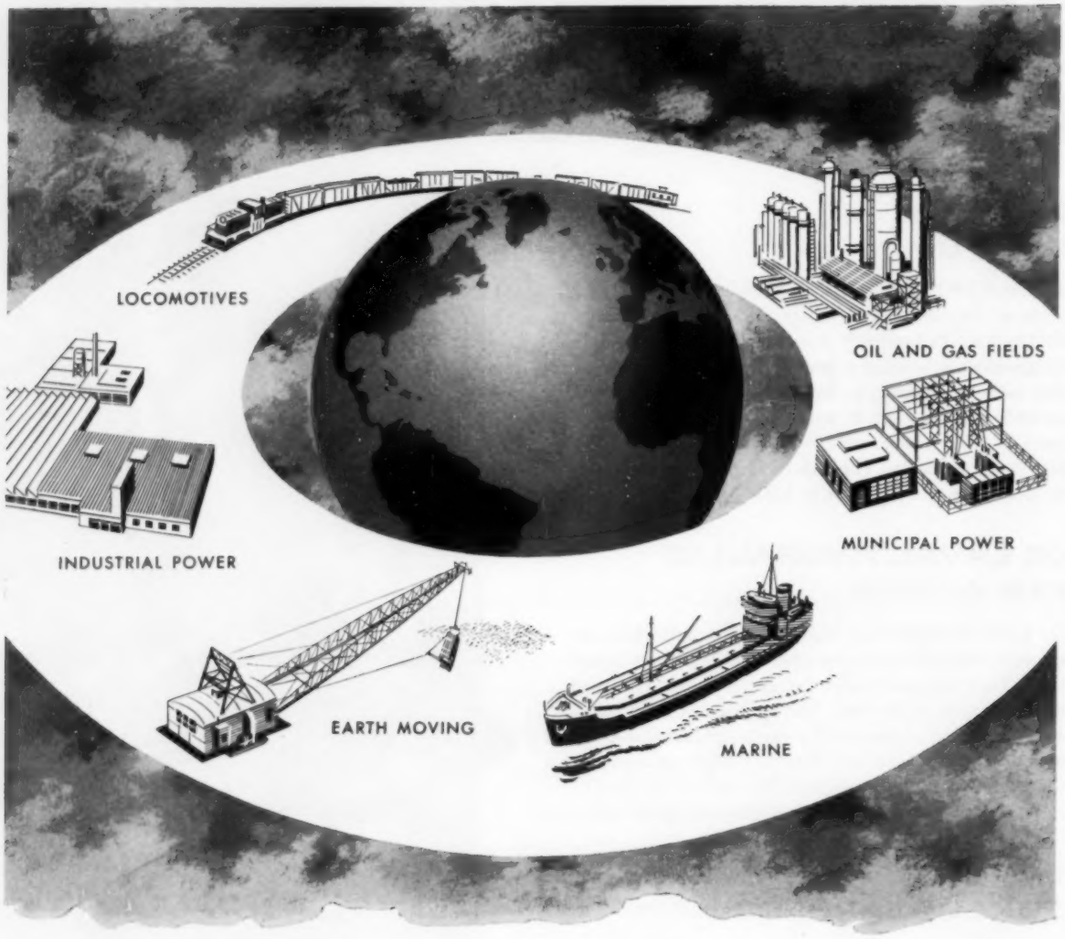

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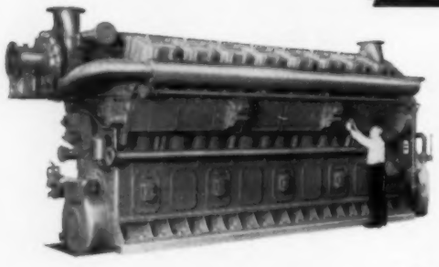

THE use of reliable Cooper-Bessemer power has spread not only to many sections of the world, but also to a wide range of heavy-duty Diesel and gas engine applications.

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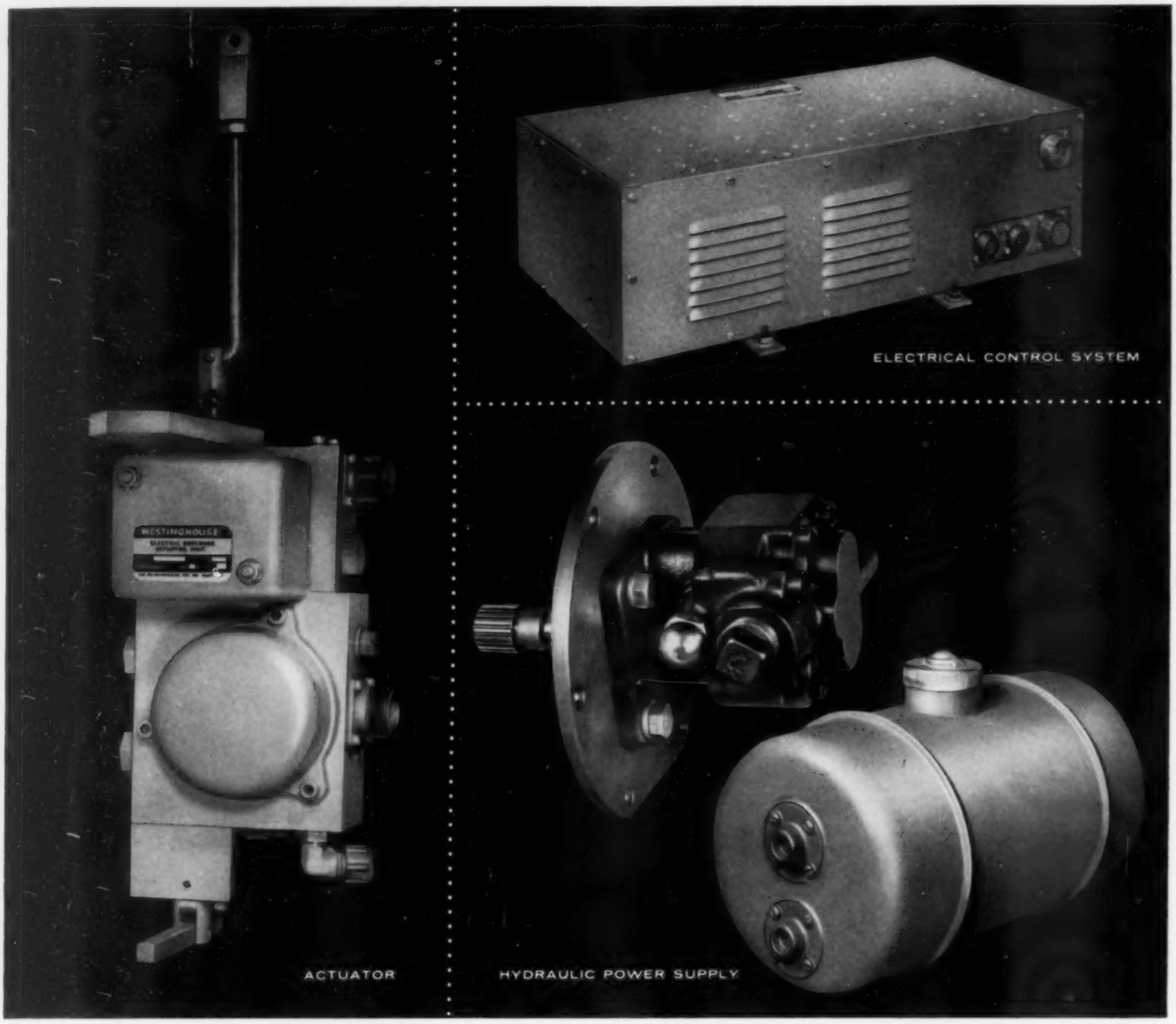

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The Westinghouse electric governor

It actually predicts speed changes and reacts faster than any other governor available! The precision power need for frequency-sensitive electronic and computer systems created the demand for an electric governor as accurate as this one by Westinghouse. Used by the military for ground power supplies for defense materiel control systems, it has been service-proved.

Now, available for any application demanding accurate control, the Westinghouse electric governor anticipates speed changes through electrical load sensing and acts fast. Conventional governors must wait for actual speed change before going into action. Moreover, electric speed sensing eliminates the design and operational problems inherent in mechanical drive systems or transmission of speed signals.

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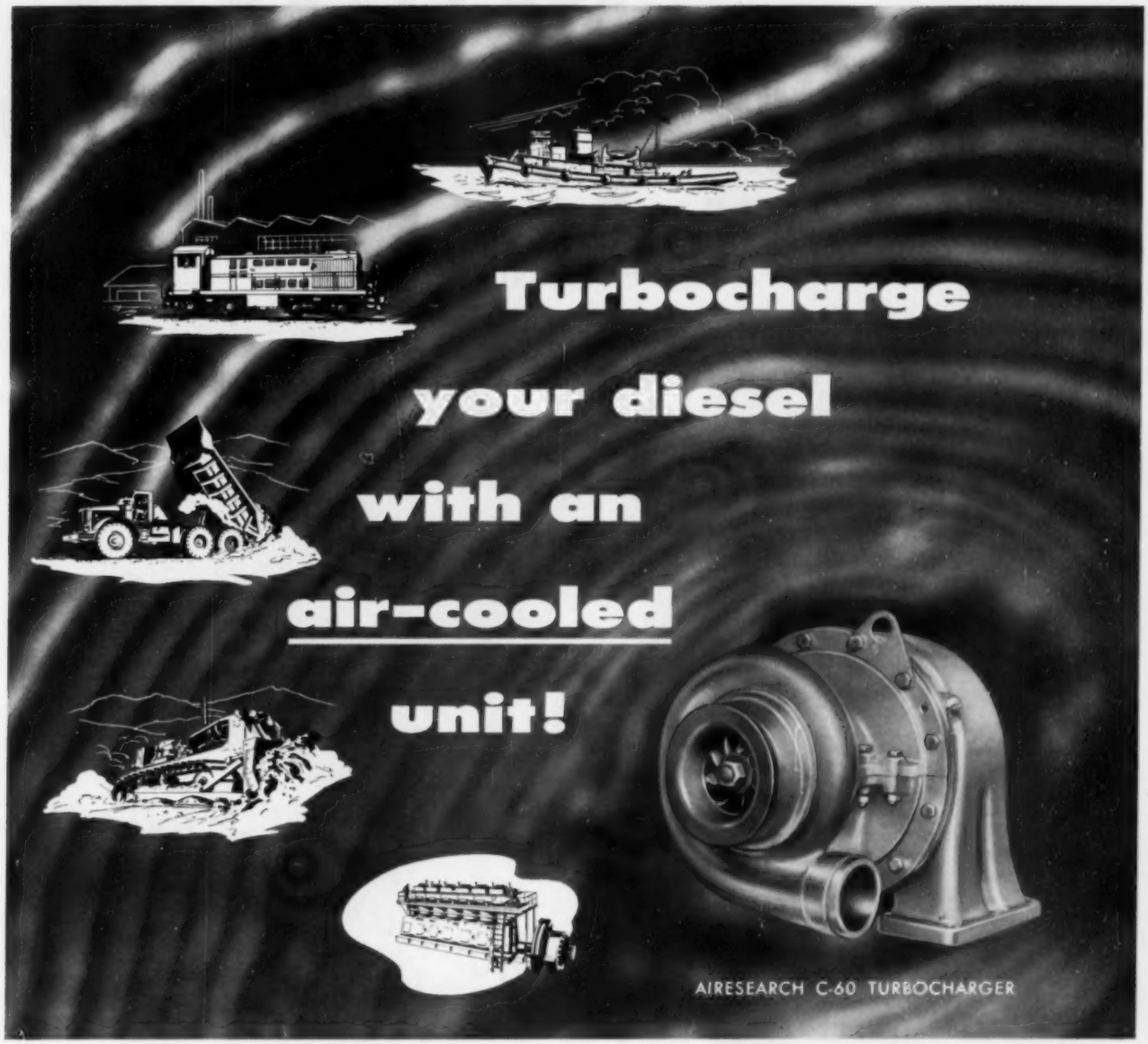

AiRESEARCH turbochargers increase power to the full capacity of the engine, yet require no extra plumbing and put no added burden on the cooling system.

The diesel industry generally has recognized the fuel-saving, noise and smoke reducing and power-adding advantages of turbocharging. But there are important differences between turbochargers. Some are difficult to service and add complicated plumbing because of the necessity for water-cooling.

All AiResearch turbochargers, from the smallest units for mobile equipment to the large, stationary power plant models, are air-cooled. Each contains a removable rotating assembly which simplifies maintenance, especially in the field. Their modern design resulted from the most extensive experience in the field of small turbomachinery in America.

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MODEL	F-51	C-60	A-60	E-100	B-100
Diameter — in. nom.	10	11.5	15.25	15.1	15.4
Length — in.	10.5	12.9	16.75	14.7	17.1
Weight — lb.	40	95	125	112	135
Output — lb/min. (Standard Conditions)	29-51	30-60	38-60	50-100	60-100

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AiResearch Industrial Division

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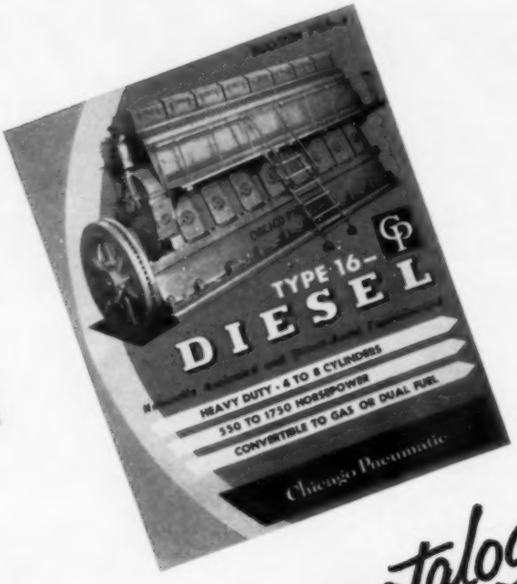

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Normally Aspirated or Supercharged

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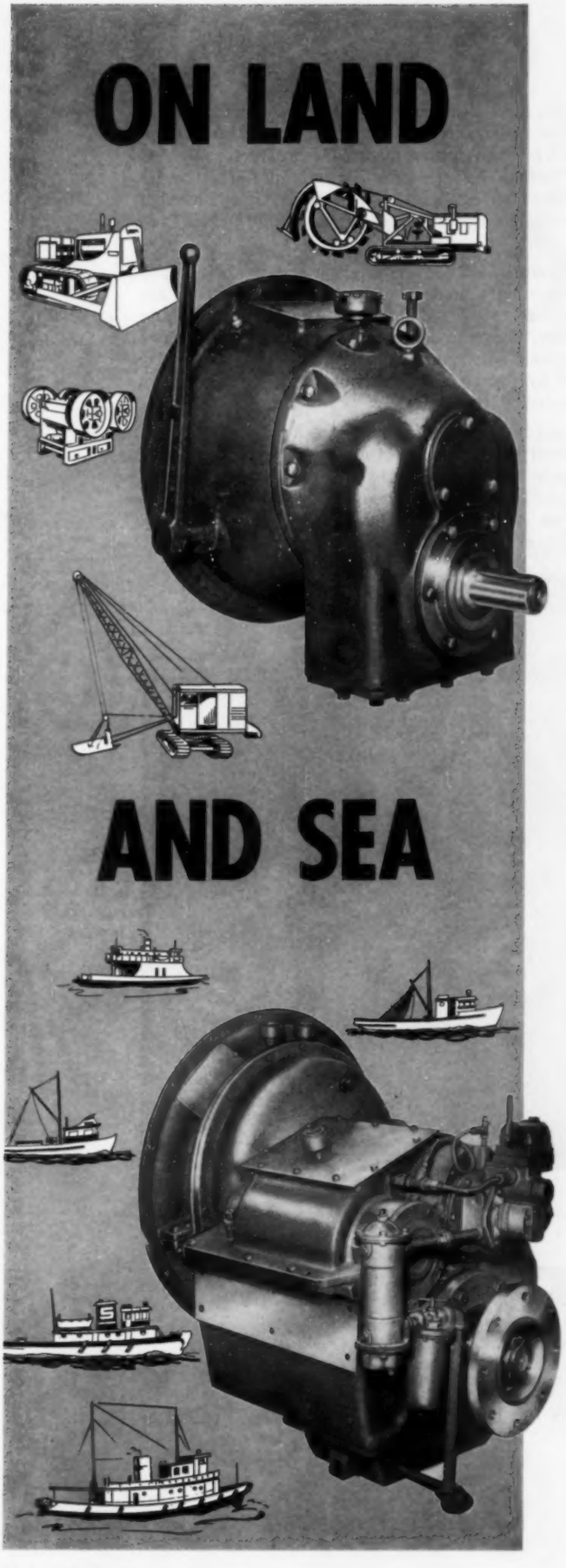

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For over fifty years the Snow-Nabstedt Gear Corporation, famous as the makers of "Joe's Gears", has been furnishing efficient, dependable power transmission for marine and industrial use. Following the tradition that engine power is only as efficient as the mechanism through which it is transmitted, S-N has constantly been a leader in the development of more efficient gears to keep pace with modern diesel engine design.

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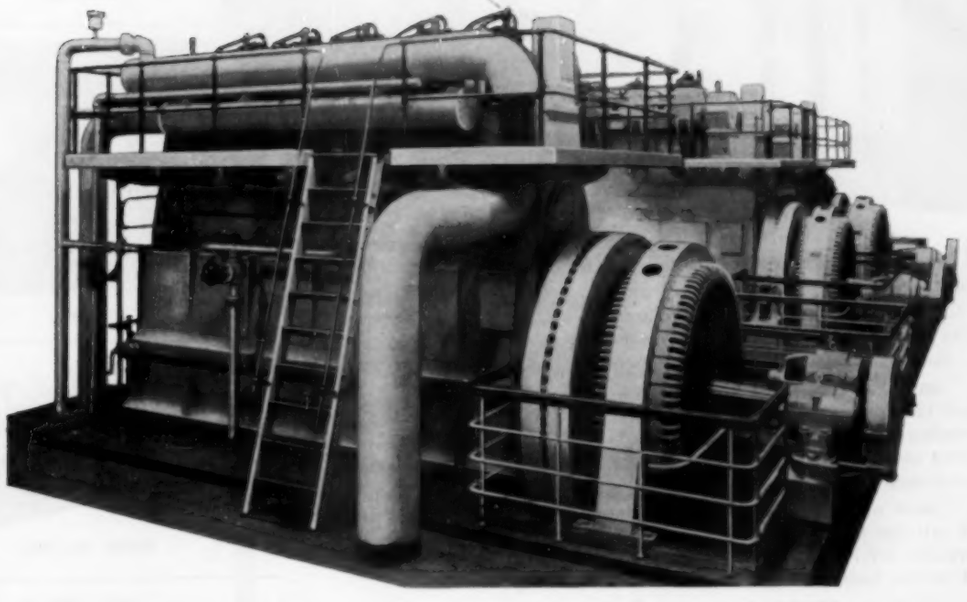

There's good reason why Sinclair RUBILENE® Oil has a great record in industrial Diesel applications. RUBILENE prevents the formation of carbon, sludge and varnish in Diesels. It stands up under highest operating temperatures, provides better lubrication protection to cylinders, pistons, rings and other vital moving parts. It cuts oil consumption, reduces service time to a minimum.

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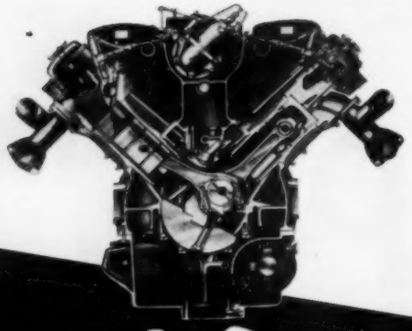

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F 2 L612	20/2000
F 3 L612	30/2000
F 4 L612	40/2000
F 6 L612	60/2000
A/F 2 L514	30/1600
A/F 3 L514	45/1600
A 4 L514	60/1800
A 6 L514/614	90/1800
A 8 L614	120/1800
A 12 L614	180/1800

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Watercooled Marine and Industrial Diesels, 2 and 4 cycle, from 3-2000 BHP in slow and medium speeds.

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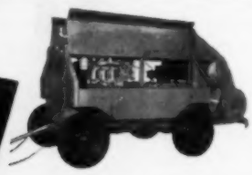
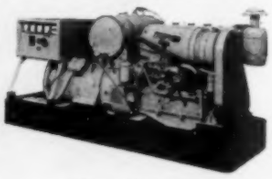


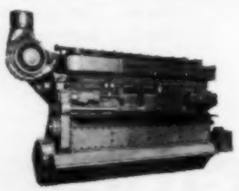
UTILITIES

MINING



DIESEL ELECTRIC

IRRIGATION



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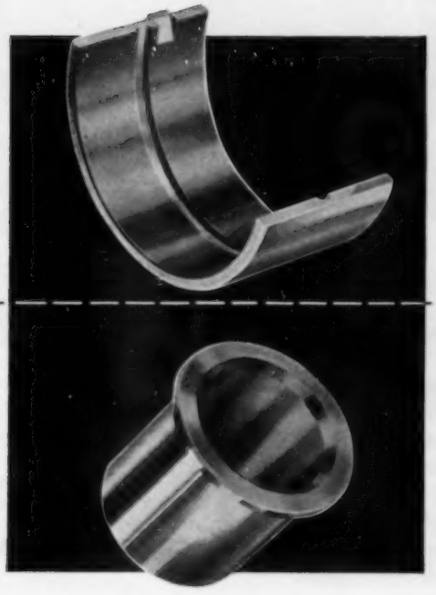

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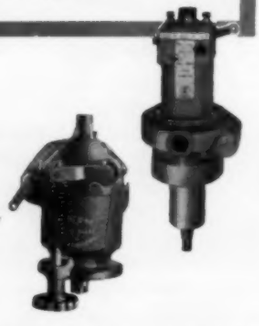

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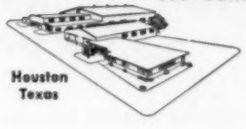

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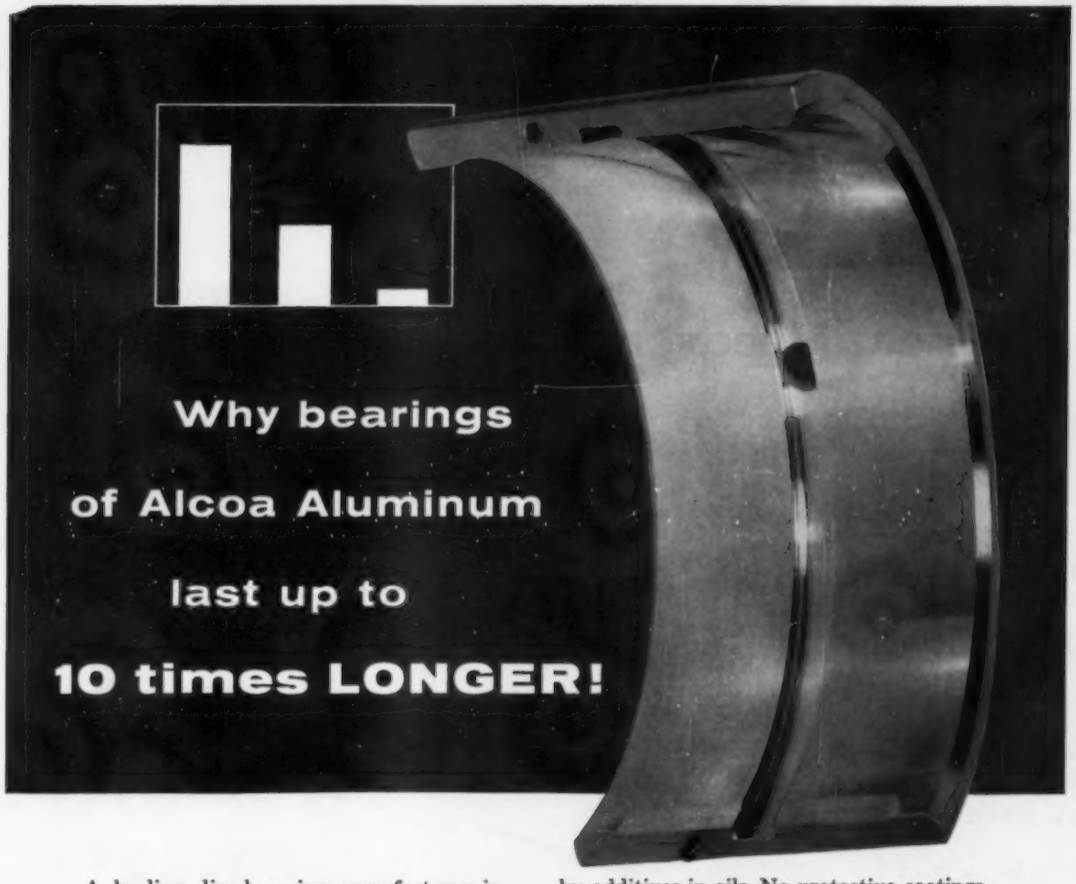

A leading diesel engine manufacturer increased the life of their crankshaft bearings *at least 10 times* by switching from babbitt to solid bearings of Alcoa® Aluminum. Bearings of Alcoa Aluminum are outperforming babbitt and bronze in hundreds of other applications—because aluminum has an *unmatched combination of advantages.*

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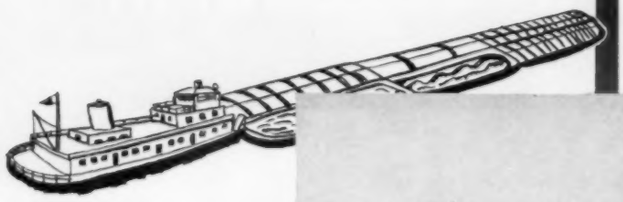

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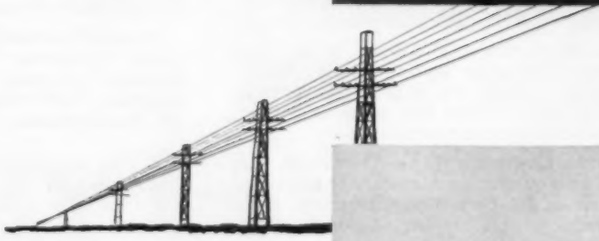

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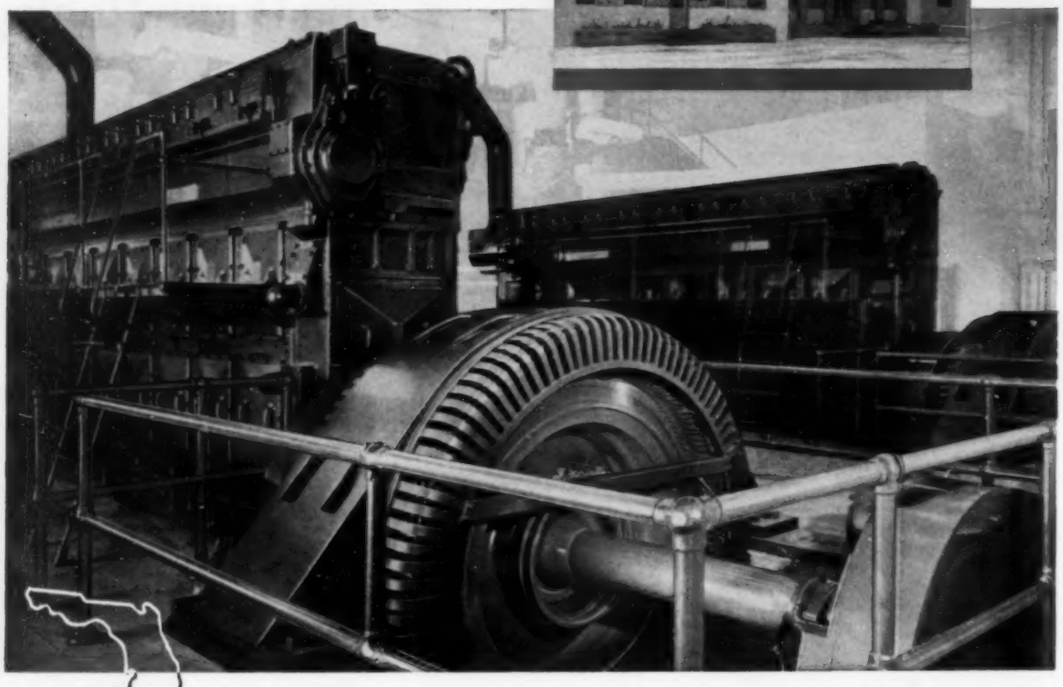

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Economical operation on low cost heavy fuel results from Superior's highly developed open chamber combustion system plus special equipment and techniques perfected by White Diesel engineers. Rugged, heavy duty construction and high quality features enable Superiors to operate with minimum maintenance even where mushrooming local demand calls for peak output.

If extreme economy under "marathon" operating conditions interests you, call or write the nearest office listed below. Let White's engineers discuss the many outstanding features of Superior and Atlas engines, ranging from 100 to 2150 HP, for power to 1500 KW.

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AIR COMPRESSOR DISCHARGE LINES—2800 Air Compressor Discharge Hose with Reusable Fittings is designed to withstand temperatures up to 500° F. without becoming brittle or cracked and to minimize carbon pickup, a major cause of line failure. In sizes up to 1¼"; for pressures up to 125 psi.

HIGH TEMPERATURE LINES — 2802 Teflon Hose and Reusable ***"super gem"*** Fittings for fluid systems subject to high temperature and corrosive fluids. Hose and fittings can be assembled with ordinary hand tools. In sizes from ¼" to 1"; for pressures up to 1500 psi.; temperature range —100° F. to +500° F.

SELF-SEALING COUPLINGS—Type 5100 (wing union nut) and Type 5110 (hex union nut) allow quick connection and disconnection of fuel, oil, hydraulic and air lines, replaces two shut-off valves. There is no loss of fluid or inclusion of air into the system on connection and disconnection of fully pressurized lines. In O.D. tube sizes from ⅛" to 1½"; for pressures up to 2000 psi.; temperature range —40° F. to +250° F.

"super gem" is an Aeroquip trademark.

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CLEVELAND DIESEL

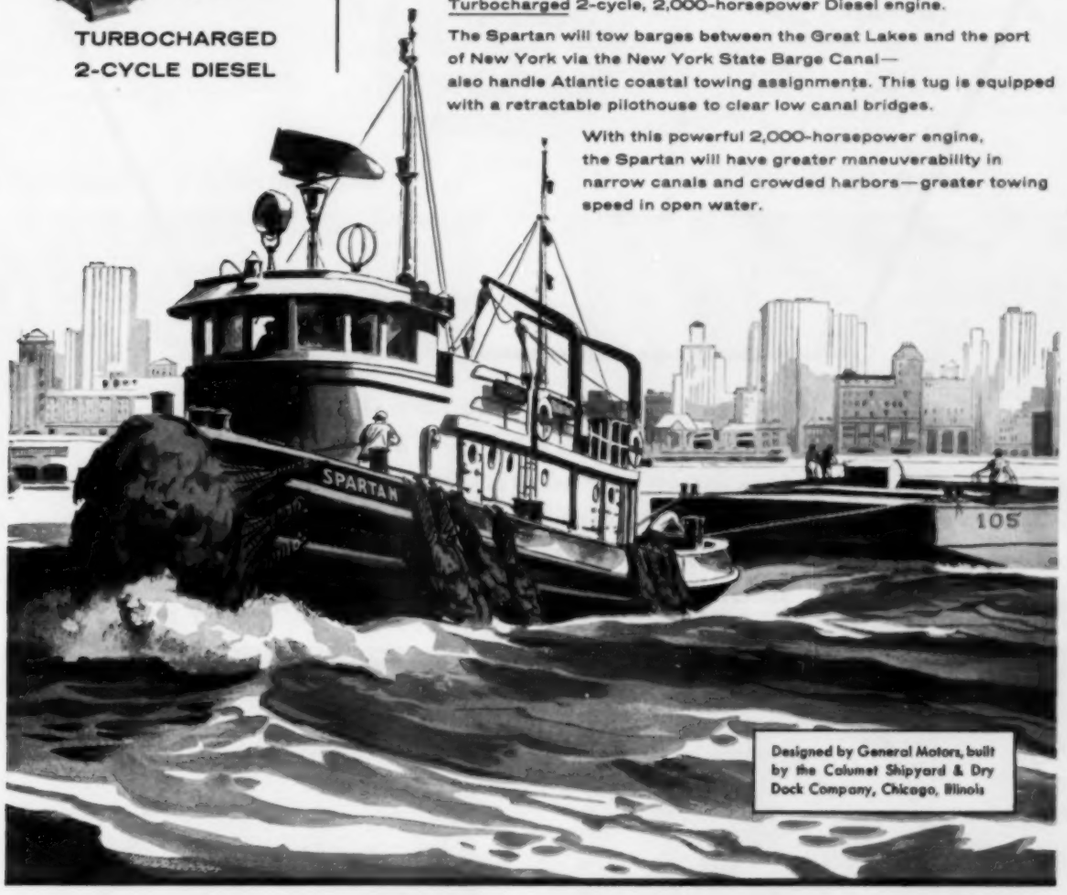
TURBOCHARGED
2-CYCLE DIESEL

2,000 horsepower in the new McWilliams Blue Line tug—Spartan

The new tug Spartan, owned and operated by the McWilliams Blue Line, is powered with a 12-cylinder Cleveland Diesel Turbocharged 2-cycle, 2,000-horsepower Diesel engine.

The Spartan will tow barges between the Great Lakes and the port of New York via the New York State Barge Canal—also handle Atlantic coastal towing assignments. This tug is equipped with a retractable pilothouse to clear low canal bridges.

With this powerful 2,000-horsepower engine, the Spartan will have greater maneuverability in narrow canals and crowded harbors—greater towing speed in open water.



Designed by General Motors, built by the Calumet Shipyard & Dry Dock Company, Chicago, Illinois

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CLEVELAND DIESEL

An Engine Division of General Motors • Cleveland 11, Ohio

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Designed and engineered to assist in cold starting of engines as low as minus 65° F. Tested, approved and used by Government agencies, engine companies, construction companies, etc.)

BUT

now used throughout the year by operators of mobile and stationary engines as it has proven that it reduces battery replacement and, by giving instant starting, saves wear and tear and, thereby, lengthens the life of the engine.

START PILOT *"Multi-Start"* Capsules (18cc)

1. Leak-proof aluminum container
2. Safe handling (awarded N.Y.C. Fire Dept. Certificate of Approval #2359)

(ACTUAL SIZE)

3. Authorized to be stored in truck cabs and aboard ships
4. Contains low ether content & supplies proper lube when needed most—during first firings)

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S. J. Groves & Sons Co., Woodbridge, N.J.

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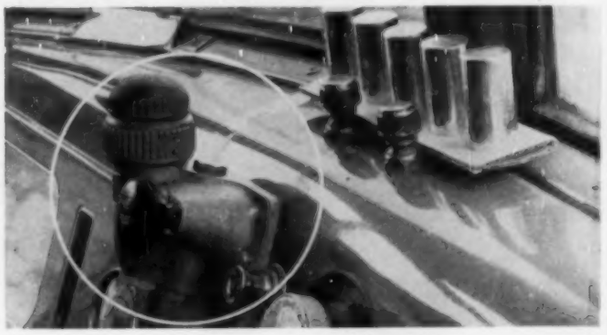
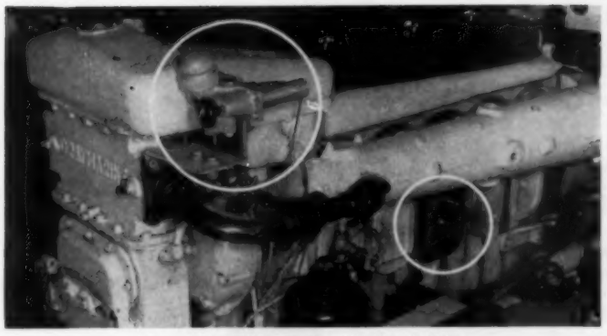


T. E. Toomey Co., Inc., Wakefield, Mass.

MARINE DIESELS



Commodore Fishing Station, Island Park, N.N.Y.

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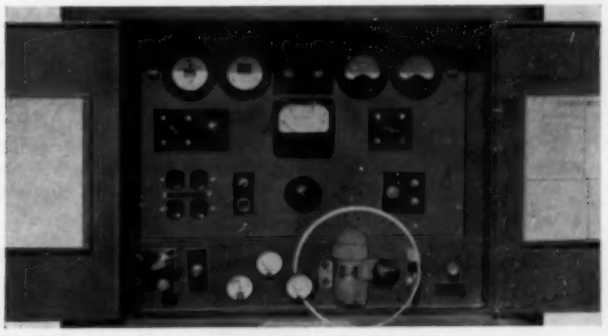

John Reiner & Co., Long Island City, N.Y.

1. Small, compact, easy to install
2. Only starting device capable to "follow through" after first ignitions, until engine fires smoothly
3. Tested and approved by major engine companies
4. Supplied to Governments of U. S. A., England, Sweden, France

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CUNO

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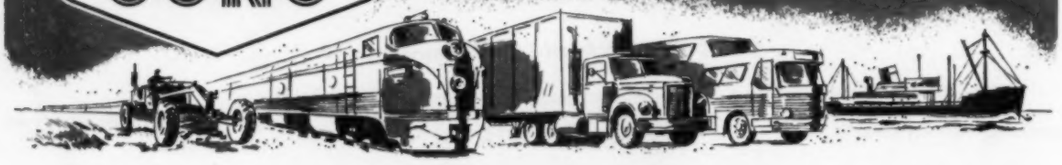
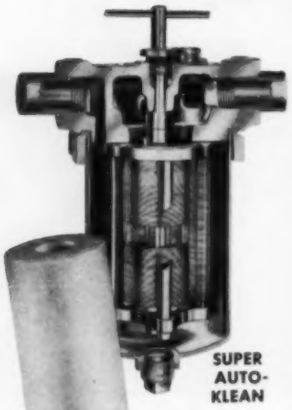


FOR EVERY DIESEL APPLICATION



LUBE OIL . . .

CUNO AUTO-KLEAN®—Metal Edge Type

Boosts engine life up to 50%. Features high flow rates in a small package. An 8" x 2¼" unit provides 40-micron filtration, handles 30 gpm of 200 SSU lube oil with only 3 psi pressure drop. All-metal construction, continuously self-cleaning, needs no changing, cannot rupture or channel. A complete line with flow rates to 4000 gpm, filtration from .030" down to 40 microns.

LUBE OIL, FUEL OIL and AIR . . .

CUNO MICRO-KLEAN®—Fiber Cartridge Type

Use economical, throw-away cartridges, occupy little space, insure fine filtration plus high flow rates at low cost. Exclusive "Graded Density" doubles dirt-holding capacity, cuts replacement costs in half! Cartridges will not rupture, channel or by-pass at the ends. Available in 10, 25, 50 or 75-micron densities. Remove *all* particles down to rated size *and* a large percentage of much smaller particles. Standard housings for flow rates to 4000 gpm.

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CUNO PORO-KLEAN®—Porous Stainless Steel

Filtration down to 5 microns. Positive protection for close-tolerance hydraulic system components. No particle discharge even under high pressure or severe vibration. Standard cartridges for Cuno Micro-Klean Housings, specially-designed cartridge-and-housing units, and custom fabricated or sintered filter elements for incorporation into pumps and other assemblies.

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So you need TORQMATIC DRIVE.

You need TORQMATIC because it quick shifts at full throttle. No lags or stalls between gears. You need TORQMATIC to eliminate the gearshift guesswork of clash box transmissions. TORQMATIC not only eliminates guesswork—it can increase engine life 47%!

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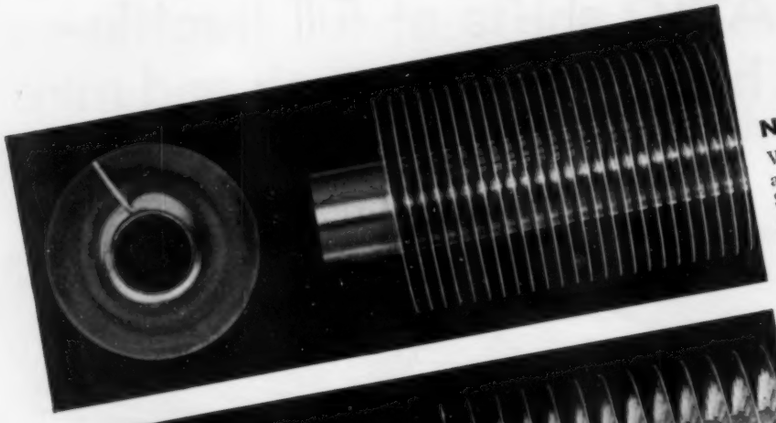
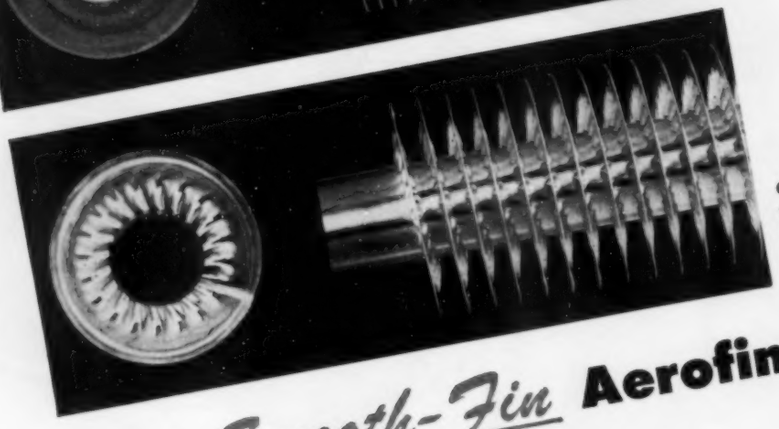


New Smooth Fins
Wide base provides ample contact surface. Smooth fins can be closely spaced without increasing resistance.



Old Type Fins
Crimped to provide necessary contact surface, widely spaced to reduce air friction.

NEW *Smooth-Fin* Aerofin Coils for Greater Capacity— Lower Resistance

Aerofin extended-surface heating and cooling coils now offer you an even greater area of effective surface — even greater capacity — per square foot of face area. Airway resistance is lowered; higher air velocities can be used. The result is extremely high heating or cooling capacity in a given space.

Compact, sturdy, standardized encased units arranged for simple, quick, economical installation.

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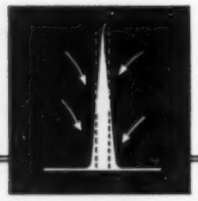

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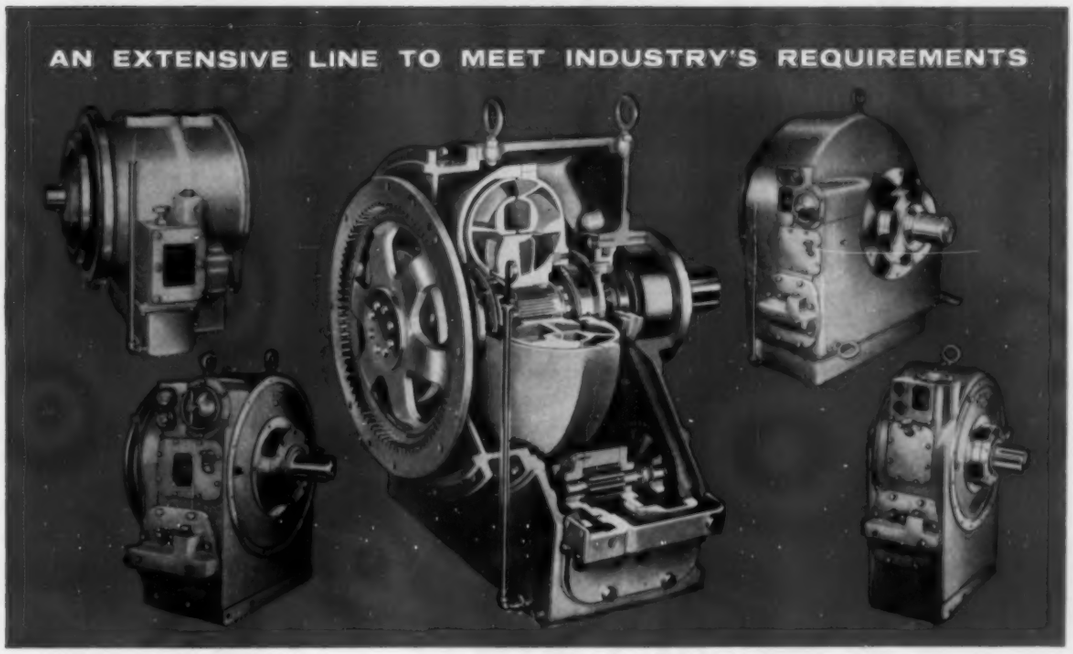
101 Greenway Ave., Syracuse 3, N. Y.

The new Aerofin smooth fins are tapered, with wide base that conducts sufficient heat between fin and tube to make the entire fin effective transfer surface.

Aerofin is sold only by manufacturers of fan system apparatus. List on request.



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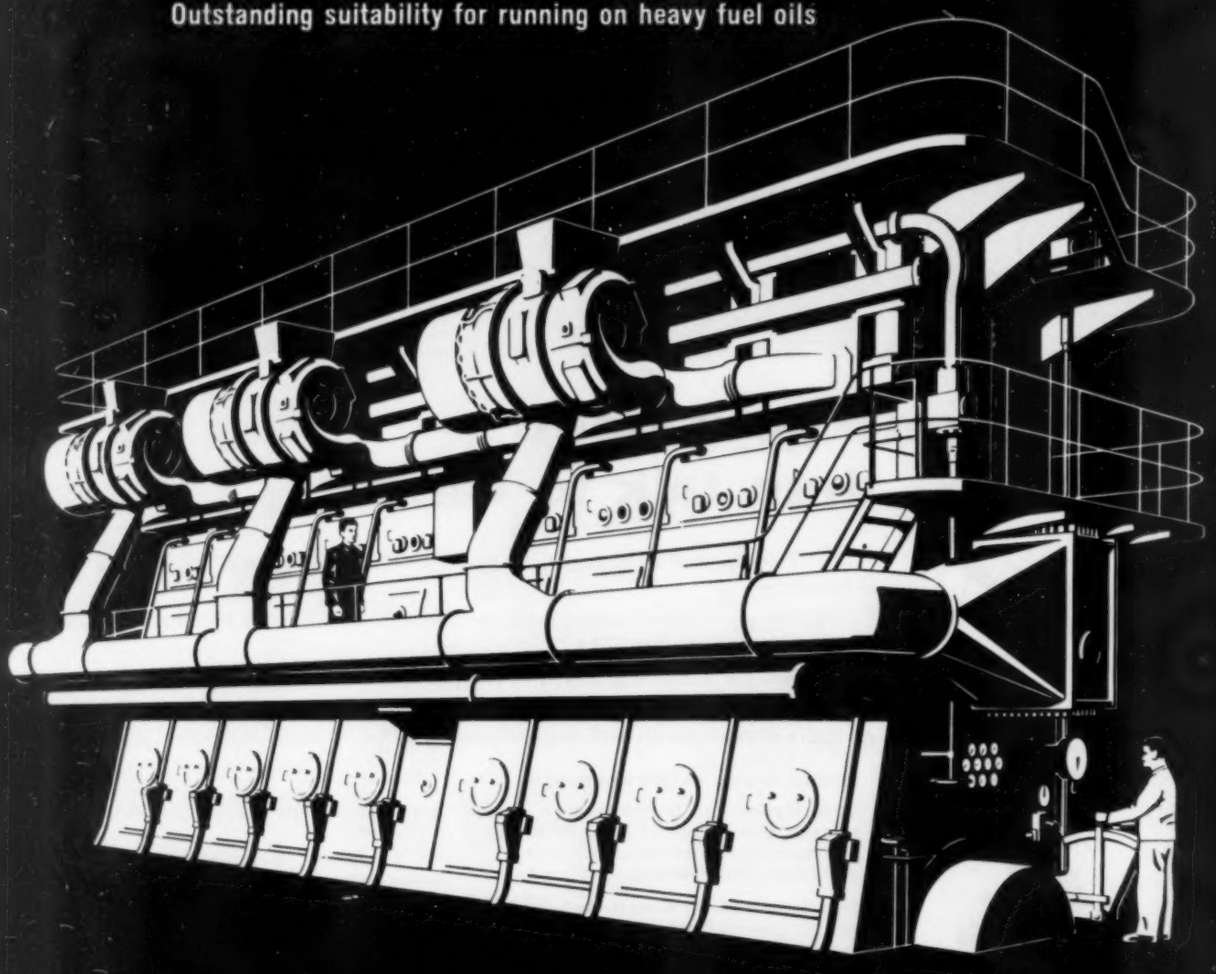
with exhaust-gas turbo-chargers, developing up to 24,000 H.P.,
for tankers, freighters and passenger vessels

Simple design incorporating Sulzer cross-scavenging
Outstanding suitability for running on heavy fuel oils



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OIL FILTERS
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Powered by two new type turbocharged diesels, each rated 2100 b. hp., equipped with Briggs filters.

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Briggs filter/separators are used on all Shell Oil Company refuelers servicing Capital Airlines Viscounts.

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BRIGGS "SUPER-FLOW" FULL FLOW CARTRIDGES

HIGH FLOW RATE, low pressure drop and unusually fine particle selection are basic characteristics. It does not remove the additives found in many petroleum products. The Briggs "super-flow" cartridge is designed for 98% plus initial removal of particles 15 microns and over. Progressively finer filtration as accumulated solids increase. Available in various sizes and flow rates.

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MADE IN SIZES FROM 2 GPM and up, these high efficiency filter/separators are sturdy, compact units of steel construction, with interior surfaces vinyl coated to resist corrosion. They filter dirt and separate water IN A SINGLE PASS THROUGH ONE CARTRIDGE IN ONE TANK . . . from light viscosity petroleum products such as gasoline, jet fuel, diesel fuel, etc.

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THE STRONG, rugged, light-weight, seamless, deep-drawn steel tanks eliminate leaks and breaks due to welded seams, thus making possible the working pressures you require. "C" clamp, "no-tool" tank tops assure the tightest of top seals without the laborious job of gasket fitting. Size and weight factors make Briggs an ideal specification where limited space and weight are problems.

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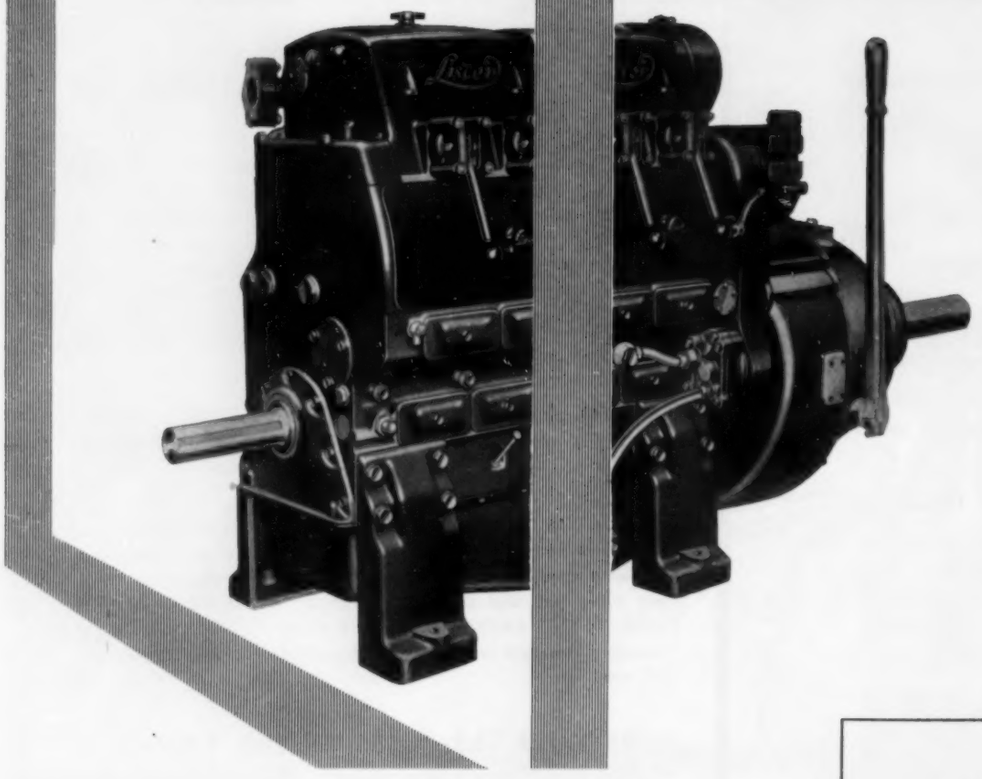
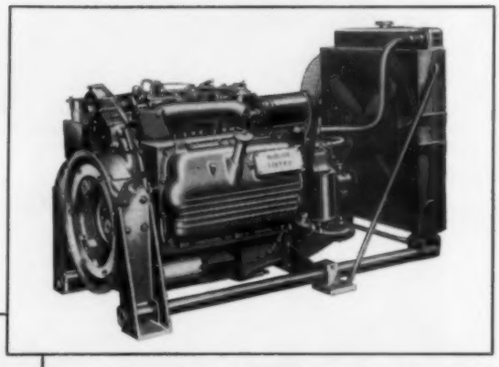


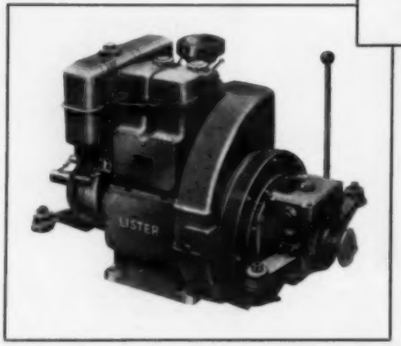
diesel engines from 3 to 1200 hp.

Air and water cooled engines for driving generating sets and all types of industrial plant on land, and for propulsion and auxiliary purposes at sea. American manufactured accessories such as radiators, electric starting equipment, clutches, gearboxes, etc., can be fitted as required.

See pages 266 & 267 for details of the complete range.



Rootes Lister 'TS3' 77 hp, radiator-cooled power pack unit.



7 hp air-cooled marine propulsion engine with reverse gear.

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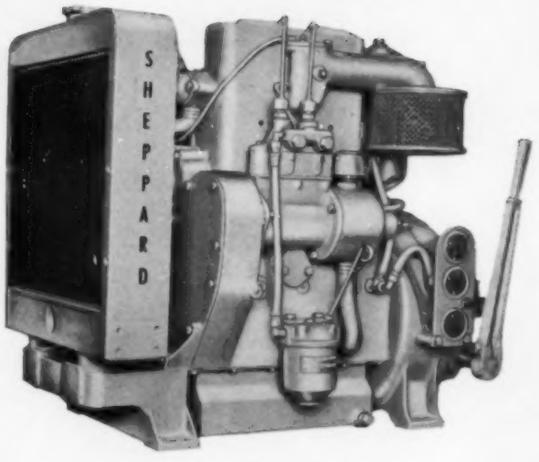
Sheppard Diesels Conquer Space

Expanding Diesel Horizons for Users of Small Engines

Working with the knowledge and experience gained in almost a quarter-century of Diesel specialization, Sheppard Engineers have succeeded in packing heavy-duty power into a line of Diesels that occupies no more space than light-weight gasoline engines. Sheppard Diesels have at last broken through the barriers of space, weight and high initial cost . . . barriers which, until now, have limited the use of Diesel in the small engine field.

N O W . . . you can replace any 3½ to 78 h.p. gasoline engine with a dependable, economical Sheppard Diesel.

Compact and power-packed as a modern rocket, Sheppard Diesels are easily installed and require no changes in equipment design. See editorial section for specifications and construction features. Write for complete engineering data on Sheppard Diesels . . . the modern Diesels for original equipment and replacement of gasoline engines.



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SHEPPARD
MODEL 17-A
DIESEL

NARROW . . 17″
SHORT . . 22¼″
LOW . . . . . 26″

SHEPPARD DIESEL POWER UNITS FROM 3½ to 78 HORSEPOWER
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SHEPPARD POWER STEERING

for every type of steerable equipment built

Sheppard has pioneered *full-time* hydraulic power steering for heavy-duty applications. Extremely compact in overall design, Sheppard Power Steering is easily installed without costly engineering in all types of agricultural, industrial, automotive and off-the-highway equipment.

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Sheppard power steering is available in 8 models. Each is an integral unit including cylinder, output pinion *plus* full mechanical steering in event of hydraulic power failure. All models can be furnished with output shaft and pitman arm.

Bring your power steering problems to Sheppard for the best possible solution with the least amount of effort. Write outlining your requirements today.

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ILLINOIS TESTING LABORATORIES, INC.

"ALNOR" PYROMETERS

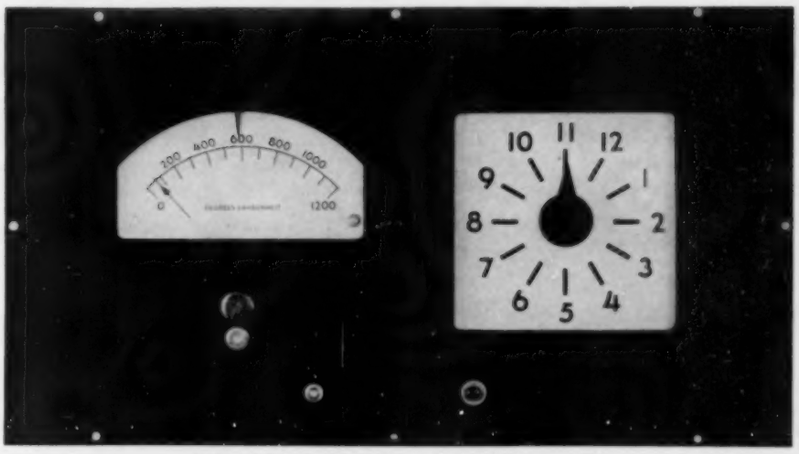
"ALNOR" Exhaust Temperature Pyrometers are specifically designed to meet the requirements of the engine industry. All instruments are rugged, direct reading millivoltmeter type. The thermocouple selector switches employ pure nickel segments and a multiplicity of phosphor-bronze brushes. Heavy duty construction is used throughout to withstand the severe service encountered in most marine and stationary engine installations.

"Alnor" Pyrotacs are contact making Pyrometers. They can be supplied to sound an alarm or shut down an engine should an excessively high or low temperature be reached. They are frequently combined with a motor operated switch so that one instrument can continuously and automatically monitor the exhaust gas temperature of each cylinder. Low range instruments are also available to sound an alarm in case of an excessively high bearing temperature.

"Alnor" Pyrometers can be supplied in a variety of styles to accommodate specific requirements. Series AX Pyrometers are intended for mounting directly on an engine. This series features an exceptionally compact design and a high torque-weight ratio. The BZ series is also intended for mounting directly on an engine. The meter can be removed from the terminal board and switch assembly so that it is particularly easy to connect.

The RT series is designed for switchboard mounting. Its five inch scale is easy to read. The meter switch and terminal chamber are individually gasketed. Series ET Pyrometers are high precision instruments having a six inch edgewise mirrored scale. Their high resistance movements make them excellent for installations using long runs of alloy connecting wire. This series is designed specifically for switchboard installations.

Many different styles and sizes of thermocouples are available in flexible detachable, rigid detachable and conventional types.

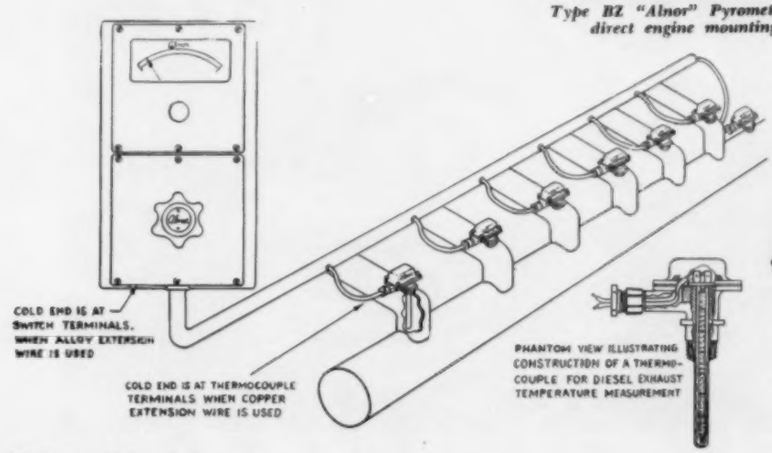


"Alnor" Pyrotac automatic contact making pyrometer.

Type FAX "Alnor" Pyrometer.

Type BZ "Alnor" Pyrometer for direct engine mounting.

Type RTT "Alnor" Pyrometer.


COLD END IS AT SWITCH TERMINALS, WHEN ALLOY EXTENSION WIRE IS USED
COLD END IS AT THERMOCOUPLE TERMINALS WHEN COPPER EXTENSION WIRE IS USED
PHANTOM VIEW ILLUSTRATING CONSTRUCTION OF A THERMOCOUPLE FOR DIESEL EXHAUST TEMPERATURE MEASUREMENT

Diagrammatic arrangement of pyrometer instrument and thermocouple.

SUPERIOR-ATLAS

MANUFACTURED BY WHITE DIESEL ENGINE DIVISION WHITE MOTOR CO.

WITH expanded research and continuing product improvement as its policy, The WHITE DIESEL ENGINE DIVISION is increasing the performance and horsepower output of its Superior and ATLAS heavy duty 4 cycle engines. Demands of modern marine and industrial diesel users are for greater output in given space. Consistent with the Superior-ATLAS tradition of quality-built heavy duty engines, today's new product from the big Springfield, Ohio plant is achieving lower specific fuel consumption, is using a minimum of replacement parts in exacting service, and has the improved basic construction that will give an engine owner extra years of service life.

Also being readied for diesel users is a new loop-scavenged two-cycle diesel built as a 90° Vee-type engine which will answer the need for a sturdier more economical engine for mobile application.

Superior Diesels for Stationary and Marine service are of the medium speed and slow speed, heavy duty, four cycle type; and are built in four bore and strokes, ranging from 215 horsepower to 2150 horsepower. The speeds range from 375 rpm. to 1100 rpm. For intermittent or standby service, the maximum ratings are somewhat greater. Turbochargers are available on all models and increase the horsepower rating above rating of naturally aspirated engine. Dual fuel engines are naturally aspirated or turbo-charged in the same models as stationary diesels.

Locomotive engines are also of the four-cycle type, built in two bores and strokes, naturally aspirated and turbocharged. The power range is from 375 horsepower to 1750 horsepower.

While there are differences in design due to differences in size, etc., all of the models are of enbloc construction and are fully enclosed. They are described here as a group.

ENGINE BASE is a one piece casting with the crossmembers machined for the main bearing shells and caps. Along the sides there are substantial flanges with deep bosses for bolting the engine to the foundation. Bedplate of Model 40L locomotive engine, also base of all Model 65 engines is a steel weldment.

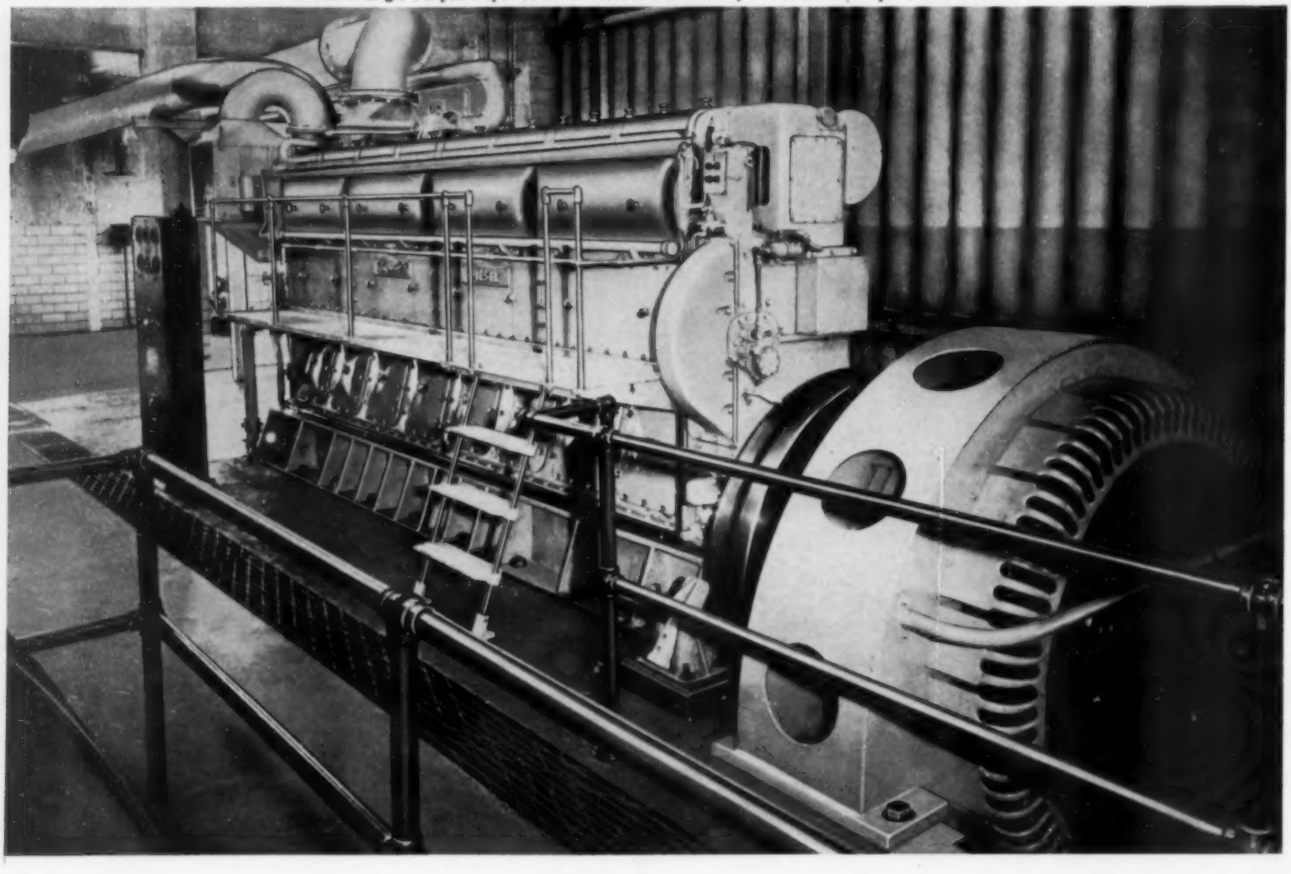
FRAME includes the upper crankcase and cylinder block as one iron casting, well ribbed for strength and rigidity. Frame of Model 65 is a steel weldment. A row of bolts along the lower outside flanges not only ties the frame to the bedplate but also insures an oil tight joint. In addition on model 60 and 80 engines, tie bolts of high tensile steel extend from the lower part of the engine base to the top of the cylinder block.

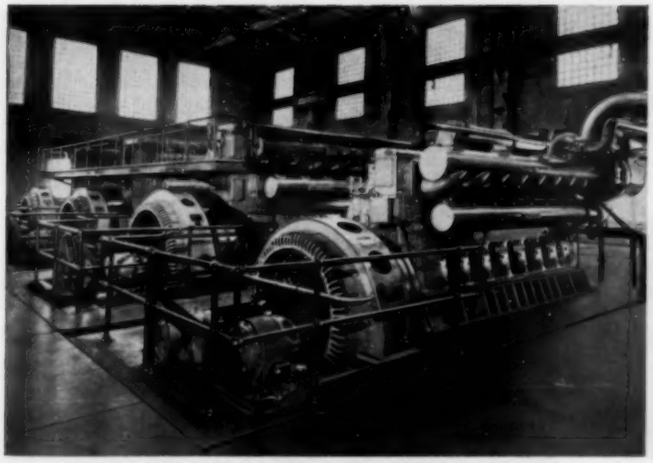
There are large openings at both sides for access to the crankcase, with easily removable covers. The camshaft, fuel injection pumps and valve gear are likewise easily accessible by means of the removable enclosing covers. There are clean-out openings in the water jackets.

CYLINDER LINERS are of removable wet sleeve type. Made of special, close-grained semi-steel mixture, they are machined all over and bore is honed to close limits.

CRANKSHAFT is forged from a single billet of high quality heat treated steel. The larger crankshafts which are not die forged are machined all over. Main journal and crankpin sizes are in excess of requirements of classifying societies. Oil passages are drilled from main bearings to crankpins. Throw rings turned on the rear end of the shaft prevent oil from traveling along the shaft and reaching the flywheel. Flywheel end of crankshaft is flanged for the power take-off. The other end of the shaft is extended for driving auxiliaries, when desired.

Modern High Output Superior Model 65-SX-8 Stationary Diesel in Municipal Power Plant.





Superior Model 65-SX-8 (1765 hp. at 600 rpm.) with three Superior Model 80-SX-8 Diesels at Petosky, Mich.

At the Missouri State Penitentiary three 1440 hp. Superior dual fuel engines constitute the largest prison Diesel plant in the nation.

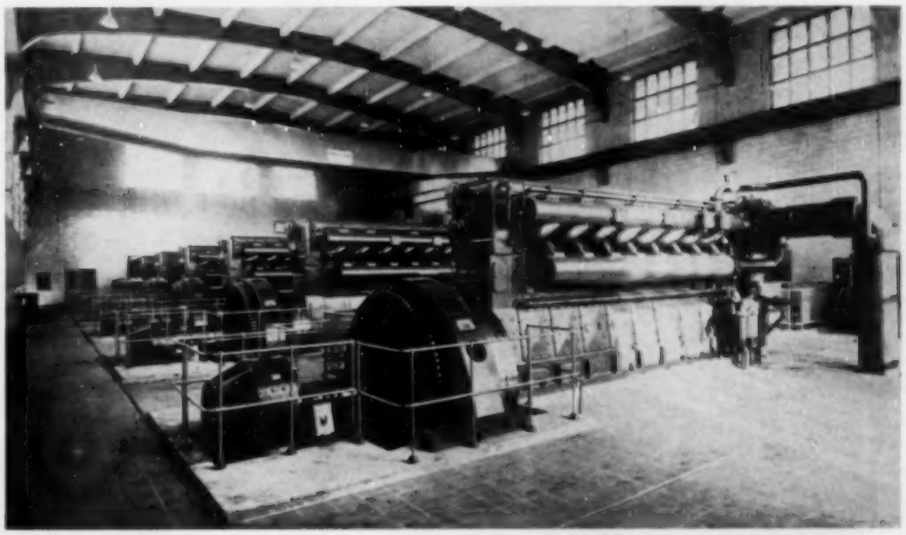
MAIN BEARINGS are of split precision type, without shims and can be replaced with minimum effort, the crankshaft being bedded in the engine base. There is a bearing at each side of each crank throw and on models 60 and 80 an additional bearing is provided for flywheel support. Upper and lower bearing shells are interchangeable.

Upper half is located in its cap by dowel pin which prevents the shell from turning. Main bearing caps are cast semi-steel, and in models 40, 65 and 80 are held down by four studs with castellated nuts and cotter keys. On model 60, caps are held in place by jack screws, the heads of which bear against the heavily ribbed arch in the frame which is over each main bearing.

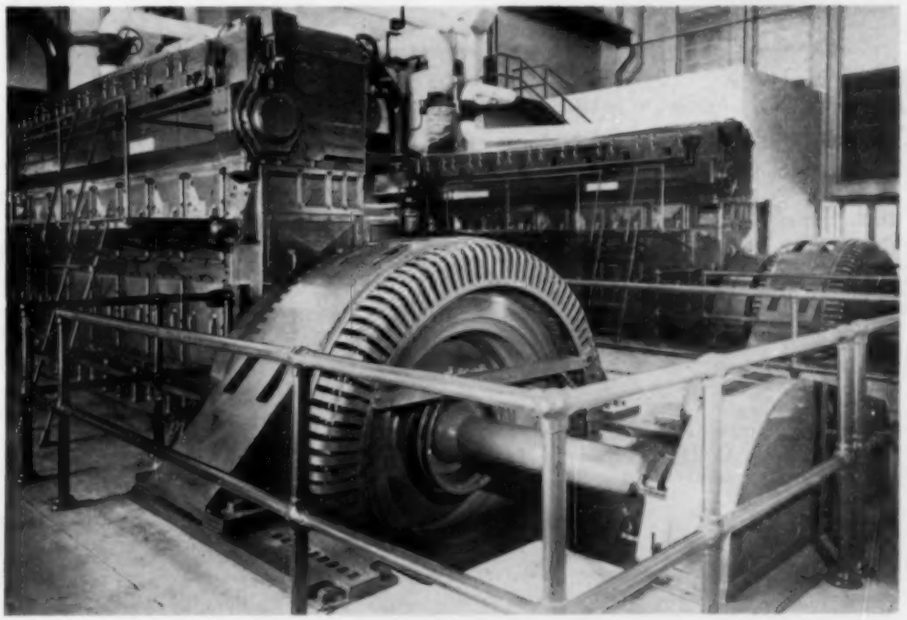
CONNECTING RODS are I-beam section forgings of high quality steel, heat treated and machined. They are rifle drilled the entire length to carry oil to the piston pin bearings and cooling oil to the pistons. Crankpin end of rod is split and has removable precision type shells, without shims. Upper and lower half shells are interchangeable. On models 40, 60, 65 and 80 the piston pin end of rod is bored to receive two removable, accurately bored, bronze bushings pressed in and so positioned as to leave an annular groove between them at the center of the rod. Oil flows into this opening from the drilled rod, part of which oil lubricates the piston pin bushing and the remainder passes through the hollow pin into the piston crown for cooling.

PISTONS for model 40 engines are oil-cooled and are cast of special semi-steel mixture, machined and ground to close limits. They are similar in construction to those used in the model 60, 65 and 80 engines. There are four compression and three oil control rings on the wet type pistons. Piston pin is of full floating type, made of steel, case hardened and ground.

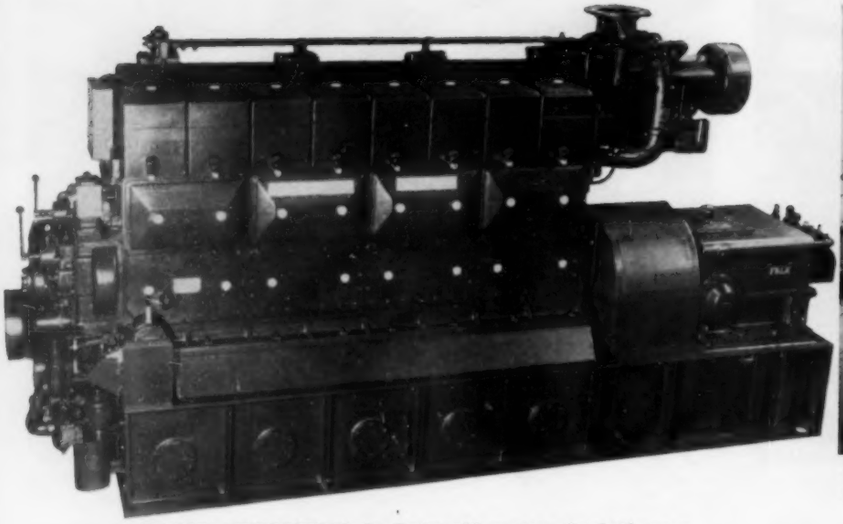
Oil cooled pistons are standard on all model 40, 60, 65 and 80 engines. The space inside of piston



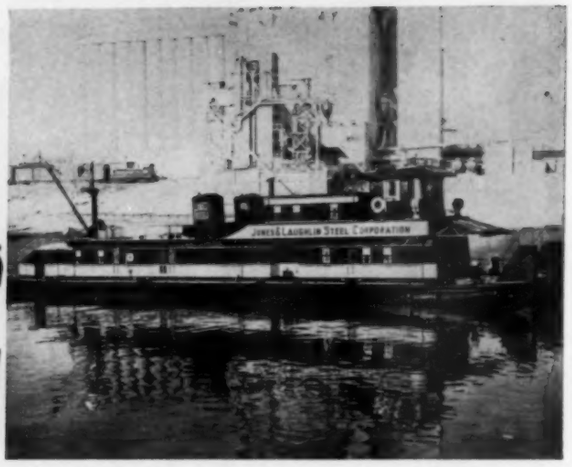
Owl's Head Sewage Treatment Plant, City of New York, powered by six Model 80 Superior, dual fuel Diesels.



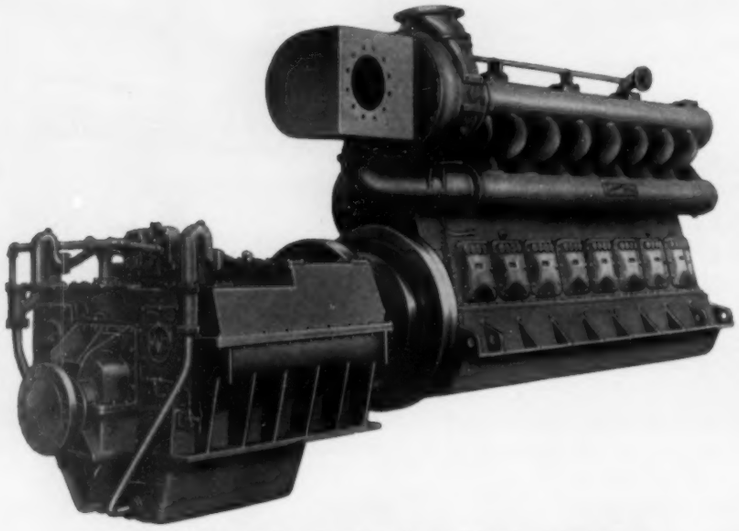
Residual fuel-burning Superior Model 80 used in Stationary and Marine Service



Model 40-S2X-8 SUPERIOR Marine Engine with reverse and reduction gear.



This towboat designed and built by the St. Louis Shipbuilding & Steel Company for the Jones and Laughlin Steel Corporation. Power is provided by two Model 40-X SUPERIOR Diesels.



Model 65-X 8-cylinder marine engine with oil-operated reverse reduction gears.

3000 hp. towboat designed and built by Dravo Corporation and propelled by two Model 65, 8-cylinder marine engines (with oil-operated reverse and reduction gears).

crown is sealed off by a plate to provide a suitable cavity in which the piston cooling oil can circulate. Drilled passages in each piston, located in diametrically opposite positions, conduct the piston cooling oil back to the sump.

CYLINDER HEADS are individual alloy iron castings designed for uniform cooling with ample air intake and exhaust passages.

Heads for model 40 engines are fitted with one inlet and one exhaust valve, fuel spray nozzle, air starting valve, air starting check valve and indicator cock.

On models 60, 65, and 80 engines, each head is fitted with two inlet and two exhaust valves, spray nozzle, air starting check valve and indicator valve. All models have cylinder head covers to enclose the valve gear. Covers are either hinged or easily removed, for inspection purposes.

CAMSHAFT is of one piece construction, manufactured from high quality steel, with hardened steel cams shrunk on and keyed. Camshaft is supported by ample bearings between each group of cams, and thrust bearings are provided at the sprocket end. It is of the overhead type, dispensing with push rods, for the model 80 engine and located in a housing extending along the control side on top of the frame. The chain drive is especially balanced to eliminate shock or vibration and has multiple strand pre-stretched chain. Details of the chain drive vary with the model engine, but fixed position adjustable idlers are standard design on all. On the models 40, 60 and 65 engines, the camshaft is supported by bearings in the engine block and may be removed sidewise as a complete unit, within the length of the engine.

COMBUSTION CHAMBER is of the open type. Fuel is injected into the combustion chamber through a multiple hole nozzle located at center.

FUEL INJECTION is by individual pump mounted above the camshaft adjacent to each cylinder. This requires only a short, high pressure fuel line to the spray valve, and makes possible the use of equal lengths for all cylinders on a given engine.

GOVERNOR on model 40 reversible marine engine is of the mechanical type. Governor actuates a linkage to control the cut-off of the fuel injection. Model 60, 65 and 80 reversible marine engines and all models of stationary engines are equipped with hydraulic governor.

LUBRICATION is by pressure feed in all cases. Oil pump is engine driven. The filtered and

cooled oil goes to the main bearings; thence to crankpin bearings, to piston pin bearings, and to piston cooling chamber; also through other lines to camshaft bearings and rocker arm bearings Cylinder liners are lubricated by splash.

COOLING WATER PUMP OR PUMPS of the centrifugal type can be either motor driven or engine driven.

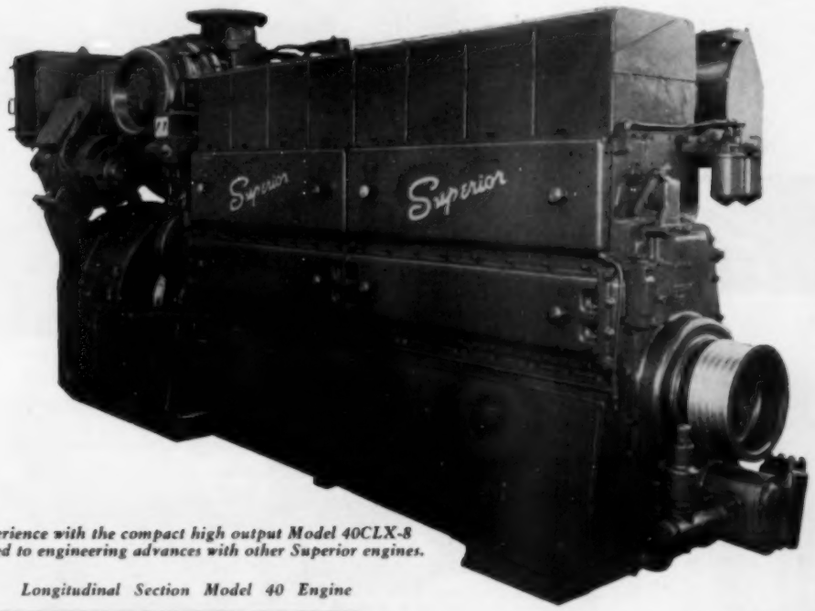
STARTING is by compressed air, controlled by hand lever or handwheel. In reversible marine engines, air operated maneuvering gear reverses the direction of rotation by sliding the camshaft longitudinally, thus bringing another set of cams into operation.

CONTROL STATION is at end of engine, and details of controls are made to suit the installation conditions. An engine-mounted gauge board is considered as standard equipment on the model 40, whereas a floor-mounted instrument and alarm control cabinet is considered standard equipment on the models 60, 65 and 80. Alarms and shutdown equipment can be furnished for any model to meet requirements of the installation.

EQUIPMENT AND ATTACHMENTS can be supplied in wide variety adapted to actual service conditions. Marine engines have a built-in thrust bearing (in reduction gear if used) or a separate Kingsbury type thrust bearing. Reduction gear or reverse and reduction gear can be furnished for marine service.

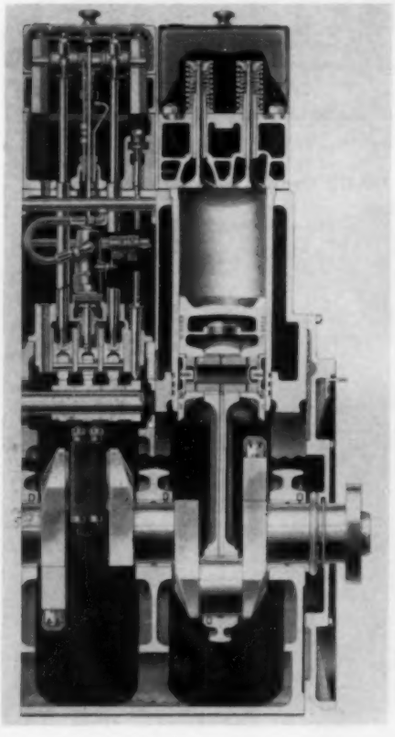
Superior Dual Fuel Diesels

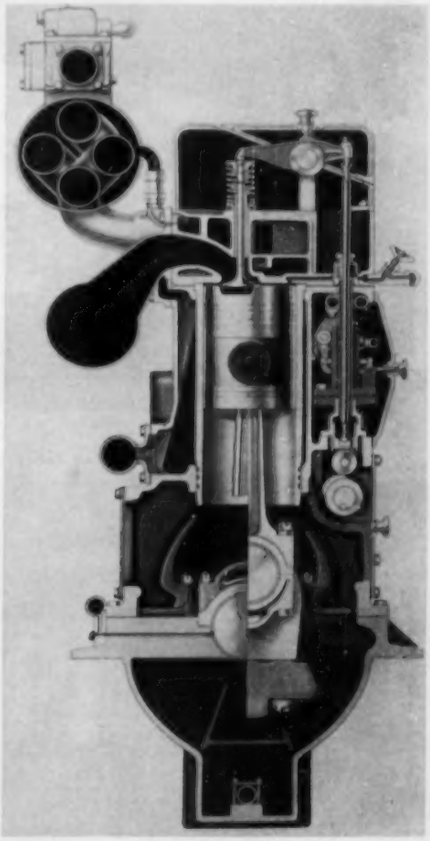
Superior Dual Fuel engines operate (a) on 100% oil fuel or (b) on natural gas, sewage disposal plant gas (or other suitable by-product gas), with only a small amount of fuel oil injected for ignition purposes. The Dual Fuel engines can be shifted immediately from 100% oil to dual fuel operation on gas, without stopping. They are of same general design and construction as the oil burning Superior Diesels. The chief difference is in the controls, governor linkage, and gas and air admission features.



Experience with the compact high output Model 40CLX-8 has led to engineering advances with other Superior engines.

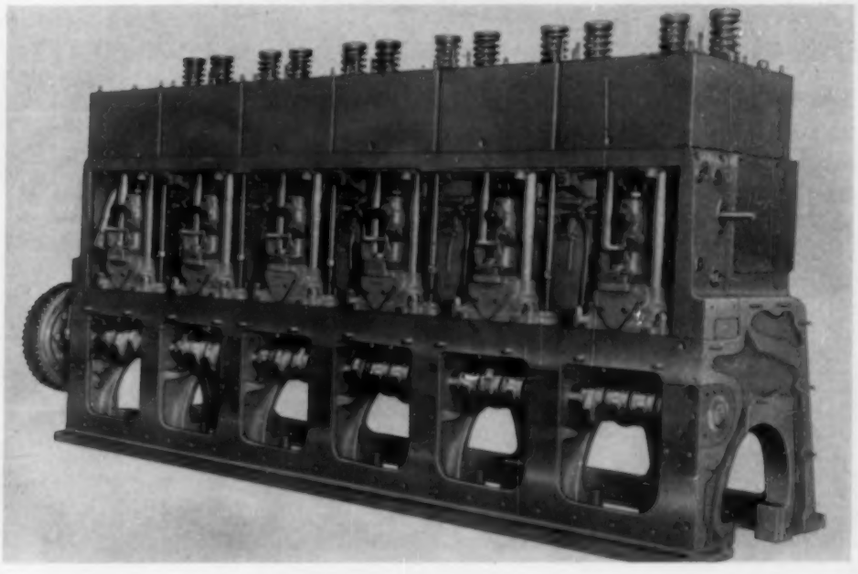
Longitudinal Section Model 40 Engine

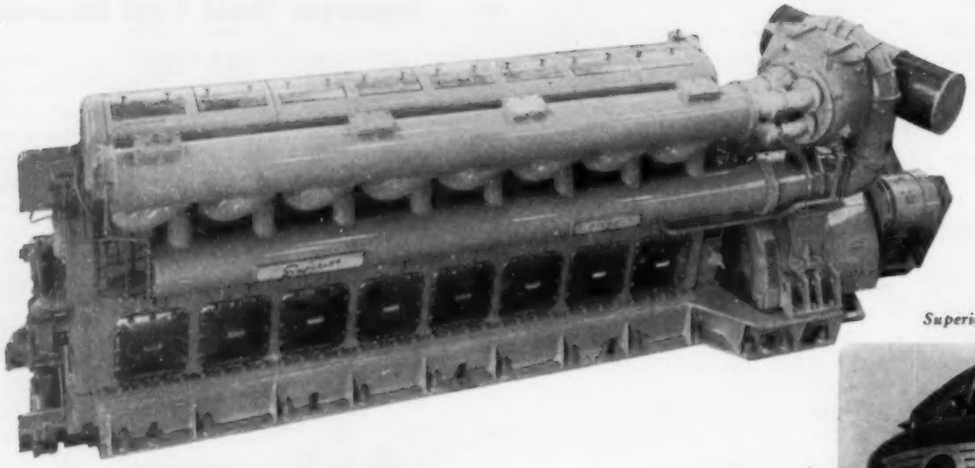




Transverse Section of Superior Model 40 Marine Engine showing improved scavenging for greater fuel economy.

Simple, rugged easily accessible block of Model 40 Engine.

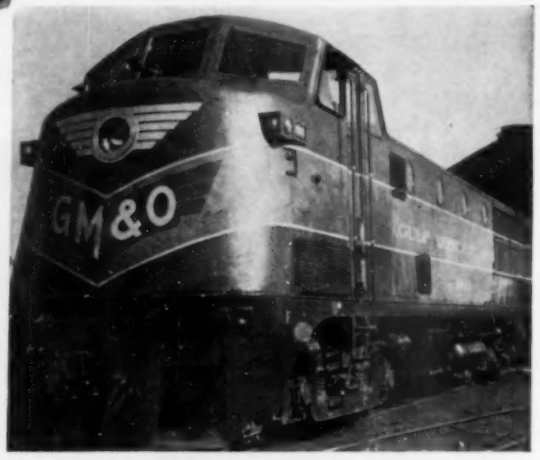


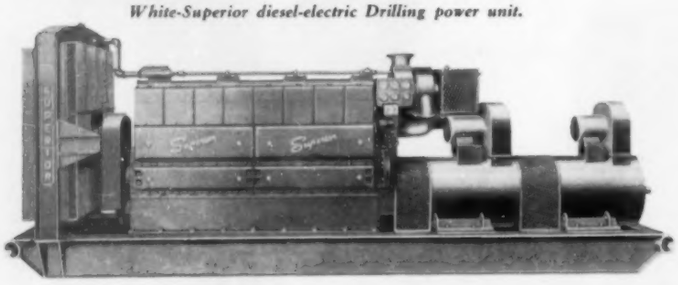


Exhaust side of Superior Model 65-LX-8 locomotive Diesel of 1750-hp.

White-Superior diesel-electric Drilling power unit.

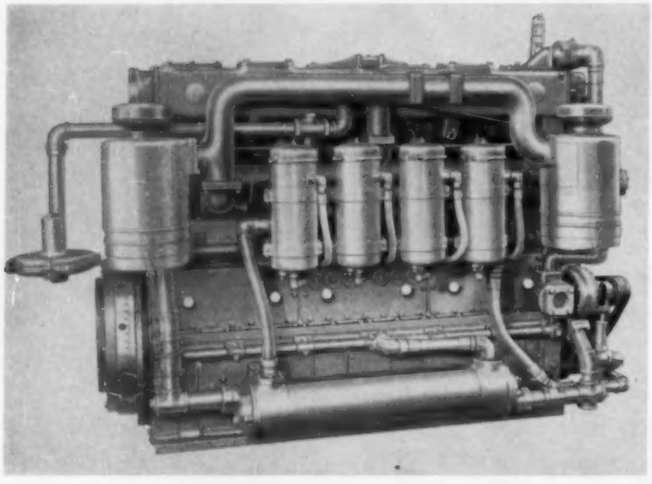
Superior powered diesel locomotive of 1600 hp.

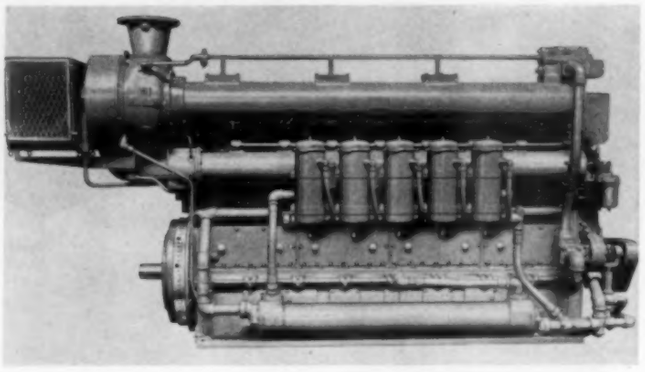




Superior 365 HP dual fuel engine.

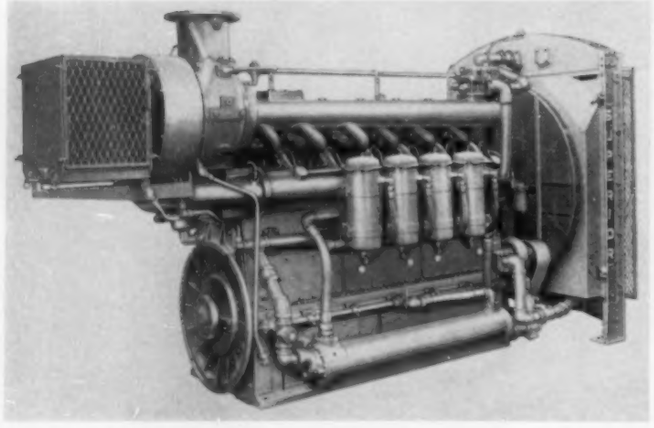
Superior PTDS-8 Drilling Engine

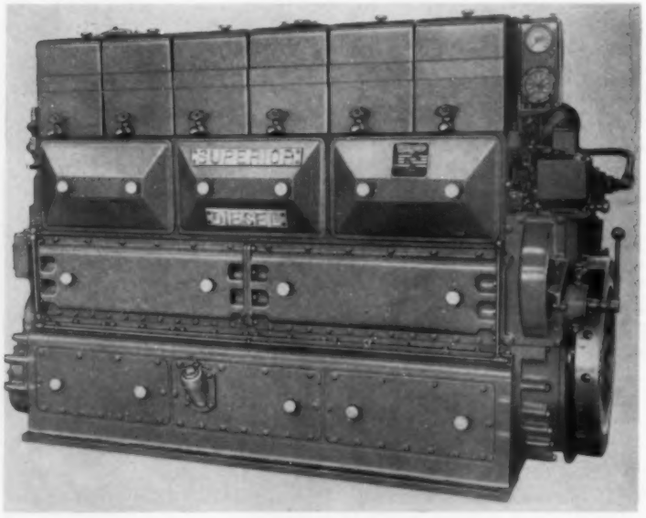




Model 40C-S-6: 360 HP Shovel & Dragline Engine

Superior PTDS-6 Drilling Engine





SUPERIOR STATIONARY DIESELS and DUAL FUEL DIESELS

Model	Cycle	No. Cyls.	HP.	Speed	Bore	Stroke	Fuel System	Starting
40-S-6	4	6	215-425	600-1000	8½	10½	Individual Pumps	Air
40-S-8	4	8	290-570	600-1000	8½	10½	Individual Pumps	Air
40-SX-6	4	6	325-700	600-1000	8½	10½	Individual Pumps	Air
40-SX-8	4	8	435-940	600-1000	8½	10½	Individual Pumps	Air
40C-6	4	6	240-460	700-1100	8½	10½	Individual Pumps	Air
40C-8	4	8	325-620	700-1100	8½	10½	Individual Pumps	Air
40C-SX-6	4	6	450-775	700-1100	8½	10½	Individual Pumps	Air
40C-SX-8	4	8	635-1025	700-1100	8½	10½	Individual Pumps	Air
60-S-6	4	6	410-530	360-514	12	15	Individual Pumps	Air
60-S-8	4	8	515-705	360-514	12	15	Individual Pumps	Air
60-SX-6	4	6	615-950	360-514	12	15	Individual Pumps	Air
60-SX-8	4	8	875-1250	360-514	12	15	Individual Pumps	Air
65-S-6	4	6	580-720	500-600	12¾	15	Individual Pumps	Air
65-S-8	4	8	775-960	500-600	12¾	15	Individual Pumps	Air
65-SX-6	4	6	1105-1600	500-600	12¾	15	Individual Pumps	Air
65-SX-8	4	8	1470-2150	500-600	12¾	15	Individual Pumps	Air
80-S-6	4	6	600-780	300-375	14½	20	Individual Pumps	Air
80-S-8	4	8	800-1040	300-375	14½	20	Individual Pumps	Air
80-SX-6	4	6	900-1400	300-375	14½	20	Individual Pumps	Air
80-SX-8	4	8	1200-1900	300-375	14½	20	Individual Pumps	Air

SUPERIOR MARINE DIESELS

Model	Cycle	No. Cyls.	HP.	Speed	Bore	Stroke	Fuel System	Starting
40-M3-6	4	6	215-425	600-1000	8½	10½	Individual Pumps	Air
40-M3-8	4	8	290-570	600-1000	8½	10½	Individual Pumps	Air
40-M3X-6	4	6	325-700	600-1000	8½	10½	Individual Pumps	Air
40-M4X-8	4	8	435-940	600-1000	8½	10½	Individual Pumps	Air
40C-6	4	6	240-460	700-1100	8½	10½	Individual Pumps	Air
40C-8	4	8	325-620	700-1100	8½	10½	Individual Pumps	Air
40C-X-6	4	6	450-775	700-1100	8½	10½	Individual Pumps	Air
40C-X-8	4	8	635-1025	700-1100	8½	10½	Individual Pumps	Air
60-M3-6	4	6	335-530	325-514	12	15	Individual Pumps	Air
60-M3-8	4	8	445-705	325-514	12	15	Individual Pumps	Air
60-M3X-6	4	6	500-950	325-514	12	15	Individual Pumps	Air
60-M4X-8	4	8	670-1250	325-514	12	15	Individual Pumps	Air
65-M-6	4	6	580-720	500-600	12¾	15	Individual Pumps	Air
65-M-8	4	8	775-960	500-600	12¾	15	Individual Pumps	Air
65-MX-6	4	6	1105-1600	500-600	12¾	15	Individual Pumps	Air
65-MX-8	4	8	1470-2150	500-600	12¾	15	Individual Pumps	Air
80-M4-6	4	6	550-780	275-375	14½	20	Individual Pumps	Air
80-M4-8	4	8	735-1040	275-375	14½	20	Individual Pumps	Air
80-M4X-6	4	6	825-1400	275-375	14½	20	Individual Pumps	Air
80-M4X-8	4	8	1100-1900	275-375	14½	20	Individual Pumps	Air

SUPERIOR LOCOMOTIVE DIESELS

Model	Cycle	No. Cyls.	HP.	Speed	Bore	Stroke	Fuel System	Starting
40-L-6	4	6	275-375	800-1100	8½	10½	Individual Pumps	Air
40-L-8	4	8	365-500	800-1100	8½	10½	Individual Pumps	Air
40-LX-6	4	6	365-500	800-1100	8½	10½	Individual Pumps	Air
40-LX-8	4	8	490-675	800-1100	8½	10½	Individual Pumps	Air
40-B-LX-6	4	6	490-675	800-1100	8½	10½	Individual Pumps	Air
40-B-LX-8	4	8	655-900	800-1100	8½	10½	Individual Pumps	Air
40C-LX-8	4	6	340-675	550-1100	8½	10½	Individual Pumps	Air
40C-LX-8	4	8	370-900	550-1100	8½	10½	Individual Pumps	Air
65-LX-6	4	6	1180-1300	600-660	12¾	15	Individual Pumps	Air
65-LX-8	4	8	1600-1750	600-660	12¾	15	Individual Pumps	Air

"X" indicates supercharged engine.

SUPERIOR OIL FIELD ENGINES

Available in standard arrangements specifically sold for oil field use, these engines carry special equipment. With the exception of the 6G-510, all are similar to and have the general appearance of the Superior Model 40, and all are well known for reliability in rugged service.

Model	Cycle	HP.	RPM	Bore	Stroke	Fuel System	Starting
Diesel & Dual Fuel							
PTD-6	4	225-365	500-900	8½	10½	Individual Pumps	Air
PTD-8	4	300-485	500-900	8½	10½	Individual Pumps	Air
PTDS-6	4	320-600	500-900	8½	10½	Individual Pumps	Air
PTDS-8	4	545-800	500-900	8½	10½	Individual Pumps	Air
Gas or Butane							
6G-510	4	190-370	600-1200	8½	9	Carb.	Air-Gas
6G-825	4	250-450	500-900	10½	10½	Carb.	Air
8G-825	4	325-600	500-900	10½	10½	Carb.	Air

ATLAS STATIONARY DIESELS

Model	Cycle	No. Cyls.	BHP.	RPM.	Bore	Stroke	Fuel System	Starting
35-S-4	4	4	100-110	900-1000	6½	8¼	Individual Pumps	Air-El
35-S-6	4	6	150-225	900-1250	6½	8¼	Individual Pumps	Air-El
35-SX-6	4	6	225-340	900-1250	6½	8¼	Individual Pumps	Air-El
45-S-4	4	4	160-190	600-720	9	10½	Individual Pumps	Air
45-S-6	4	6	240-300	600-750	9	10½	Individual Pumps	Air
45-S-8	4	8	320-400	600-750	9	10½	Individual Pumps	Air
45-SX-6	4	6	360-450	600-750	9	10½	Individual Pumps	Air
45-SX-8	4	8	480-600	600-750	9	10½	Individual Pumps	Air
76-S-6	4	6	450-500	360-400	13	16	Individual Pumps	Air
76-SX-6	4	6	675-750	360-400	13	16	Individual Pumps	Air

"X" indicates supercharged engine.

ATLAS MARINE DIESELS

Model	Cycle	No. Cyls.	BHP.	RPM.—Engine	Ratio—Propeller RPM.	Bore	Stroke	Fuel System	Starting
35-S-4	4	4	100-110	900-1000	2:1 or 3:1	6½	8¼	Individual Pumps	Air-El
35-S-6	4	6	145-225	900-1250	2:1 or 3:1	6½	8¼	Individual Pumps	Air-El
35-SX-6	4	6	225-340	900-1250	2:1 or 3:1	6½	8¼	Individual Pumps	Air-El
**45-S-4	4	4	160	600	2:1	9	10½	Individual Pumps	Air
**45-S-6	4	6	240-300	600-750	2:1	9	10½	Individual Pumps	Air
**45-S-8	4	8	320-400	600-750	2:1	9	10½	Individual Pumps	Air
**45-SX-6	4	6	360-450	600-750	2:1	9	10½	Individual Pumps	Air
**45-SX-8	4	8	480-600	600-750	2:1	9	10½	Individual Pumps	Air
**45-M-6	4	6	240-300	600-750	2:1	9	10½	Individual Pumps	Air
**45-M-8	4	8	320-400	600-750	2:1	9	10½	Individual Pumps	Air
**45-MX-6	4	6	360-450	600-750	2:1 or 2½:1	9	10½	Individual Pumps	Air
**45-MX-8	4	8	480-600	600-750	2:1, 2½:1, 2.71:1	9	10½	Individual Pumps	Air

"S" indicates single direction of rotation. Marine propulsion engines with single direction of rotation have a reverse gear.

"M" indicates a reversible marine engine.

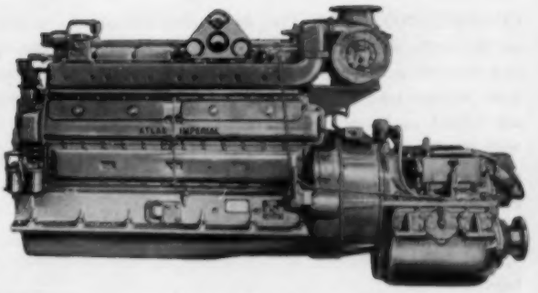
"X" indicates a supercharged engine.

**Deduct 6% from BHP. ratings of all 45-S and 45-SX marine engines to allow for friction loss in reverse and reduction gear, thereby to ascertain Net Horsepower delivered to propeller shaft. Deduct 3% from BHP. ratings of all 45-M and 45-MX engines to allow for friction loss in reduction gear, thereby to obtain Net Horsepower to propeller shaft.

ATLAS DIESELS

Model 35, 6½-in. bore x 8¼-in. stroke, and Model 45, 9-in. bore x 10½-in. stroke Diesels are of medium speed. These with Model 76, 13-in. bore x 16-in. stroke, slow speed diesels, all have individual pump fuel injection system and have the valve gear completely enclosed, as well as having complete enclosure for all other operating members.

The foregoing table of models, horsepower ratings, speeds, etc., gives information which supplemented by the accompanying illustrations will give a good idea of the various Atlas Diesel models. More complete information and descriptive bulletin applying specifically to any of the engines tabulated will be furnished on request. The following is a partial description of Model 35, 35X, 45 and 45X Atlas Diesels, both stationary and marine.



Atlas heavy duty, enclosed type, medium speed marine engine, Model 35, with reverse-reduction gear.

The Ram Class . . . Stock 70 ft. Towboats built by Dravo Corporation, each use two 35-S2X-6 ATLAS engines.

This 65 ft. Nova Scotia fishing dragger has the 195 hp. ATLAS 35 aboard.

Models 35, 35X, 45 and 45X, Atlas Diesels

These engines are of the vertical, 4 cycle, individual pump mechanical fuel injection type, fully enclosed and pressure lubricated throughout, with cylinders in line and enbloc.

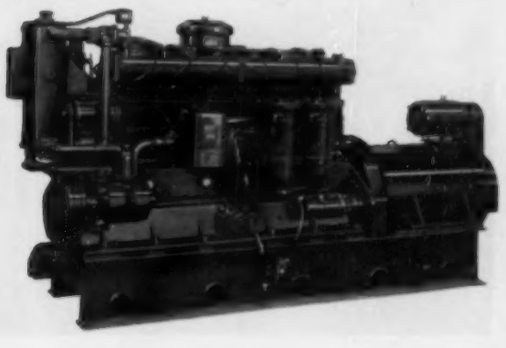
HORSEPOWER RATINGS—The speeds and horsepower ratings are for continuous service. The conservative ratings contribute to economical operation and long life.

STARTING—The engines are air started by means of camshaft operated air starting valves and check valves in the cylinder heads. Normally the cam operated starting valves are held free by means of springs but are automatically brought into engagement by the compressed air during the starting cycle. The fuel cam also operates the air starting valves. Electric starting is also available on the Model 35.

CRANKSHAFT—The crankshaft is forged from a solid billet of high grade open hearth steel, meeting classification societies' requirements. The shaft is machined all over; all journals being accurately finished and polished. Drilled passages carry lubricating oil from the main bearings to the crank pins.

MAIN BEARINGS—The crankshaft bearings are of the precision type, accurately machined for exact bearing clearances on the shaft journals. All bearings are pressure lubricated and generous bearing areas insure long life.

Model 35-S-6 equipped for electric starting in generator service.



Model 35, 4-cylinder engine with generator.

CONNECTING RODS—The connecting rod is an H section drop forging of alloy steel. Upper end carries a bronze bushing for the piston pin. Marine type steel crank pin bearing boxes are bolted to lower end of rod and are fitted with precision type crank pin bearing shells. Four crank pin bearing bolts are provided. Another pair of smaller bolts hold bearing boxes together on the crankshaft when pistons and rods are pulled.

ENGINE BASE—Base is of high grade cast iron, heavily ribbed, rigidly supporting main bearings and entire engine. Generous footing is provided to maintain alignment of engine.

FRAME OR CRANKCASE—The frame (Model 45 only) is a heavily ribbed, box casting which carries the camshaft assembly and supports the cylinder block. Large, easily removable covers at both sides give easy access to main and connecting rod bearings.

CYLINDER BLOCK AND LINERS—The cylinder block casting carries the removable cylinder liners which are fitted against gaskets at the top and sealed at the bottom by rubber rings, allowing free expansion. The Model 45 cylinder block is secured to the base and center frame by studs extending from large nuts underneath the main bearing member of the base through the frame and cylinder block bosses. A chamber in the side of the cylinder block accommodates the individual fuel injection pumps. Easily removable covers make the fuel pumps readily accessible. The Model 35, being smaller in size, has no center frame, but the same type of studs are used to secure the cylinder block to the base.

PISTON—The piston is designed for even distribution of thrust load and for efficient lubrication. In the supercharged Model 45, the pistons are oil cooled. Pistons are of alloy cast iron, heat treated in the Model 45, and of high grade aluminum alloy in the Model 35, and ground to close tolerances. The full floating type piston pin is case hardened and ground.

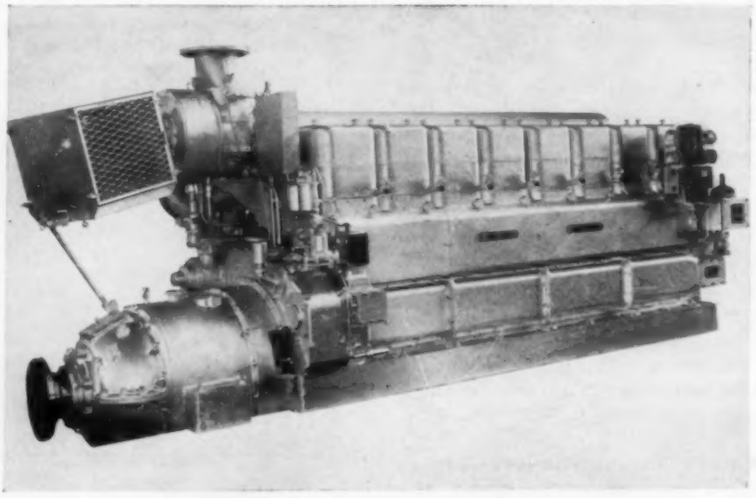
CYLINDER HEADS are individual castings of alloy iron, normalized to relieve casting strains. Copper gaskets seal joints between heads and liners, and cooling water is carried from the cylinder block to the heads through bronze ferrules sealed with rubber grommets. The heads have enclosing covers and valve operating mechanism is pressure lubricated. The lubricating oil from the heads is returned to the crankcase by tubes extending through the fuel pump chamber in the cylinder block, which tubes enclose the valve push rods.

VALVES—On the Model 45 the intake and exhaust valves are identical and dual valve springs are used. On Model 35, the exhaust valves are ¼" smaller than the intake. Valves are of austenitic type steel with hardened stem ends.

CAMSHAFT AND GEAR TRAIN—The Model 45 camshaft is mounted in removable bronze-bushed pressure lubricated bearings. The helical gear train is located at flywheel end of engine, and provides drives for auxiliaries including lubricating oil, fuel and water pumps, and tachometers. Direct reversible marine engines have dual cams, for ahead and astern operation. The two cams for each valve are in one piece, machined with a ramp between the cam noses on which the lifter rollers ride when the shaft is shifted for maneuvering. The fuel cams operate directly against the fuel pump lifters, which also serve the air starting valves. Model 35 camshaft is driven from a helical gear drive opposite the flywheel end of the engine. The engine is built for single rotation.

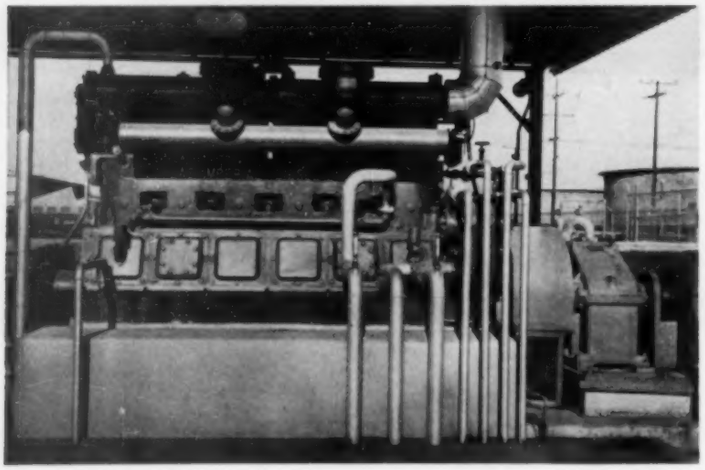
FUEL SYSTEM—Scintilla or Bosch or equal fuel injection equipment is used for Models 45 and 35. Individual fuel pumps are mounted in a chamber in the cylinder block above the camshaft and are connected to the injection valves in the cylinder heads by short individual tubes entirely enclosed within the cylinder head covers. A gear type fuel service pump maintains positive suction pressure on the injection pumps, with a duplex type fuel filter in the line between the service pump and the injection pumps.

GOVERNOR—Standard governor for Models 35 and 45 are of the flyball type, gear driven from camshaft and enclosed in an oil tight case. The governor regulates the speed of the engine by controlling fuel pump control racks. Adjustable levers which operate the fuel pump racks are provided with follower springs to permit continued control of the engine by the governor in the event of sticking of any of the fuel pump racks. For ac. generator service, hydraulic type governor is generally used.

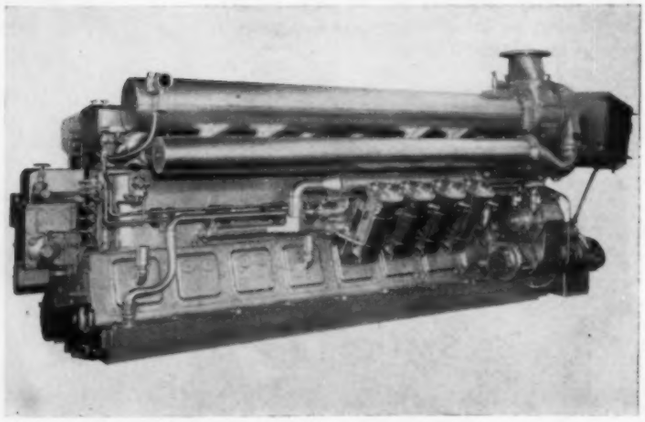


Model 45-X-8 Atlas Marine Diesel used in workboats.

Model 45 engine in pumping service in California.



Exhaust side view, 8 cylinder Model 45-M5X-8.

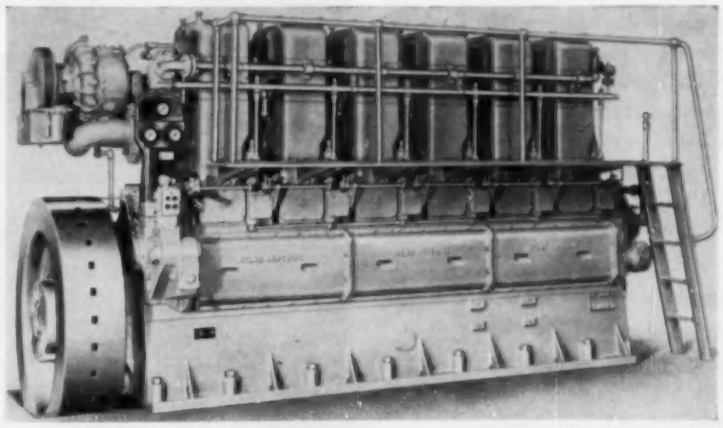


LUBRICATING SYSTEM—Gear type lubricating oil pressure and sump pumps are provided which are reversible on direct reversible marine engines. The sump pump delivers the oil from the engine base to the day tank. The pressure pump discharges through a full flow type lubricating oil filter and through shell and tube type oil cooler to the main lubricating oil header. Secondary headers serve the cylinder heads and camshaft bearings. A spring loaded relief valve maintains the desired pressure on the system.

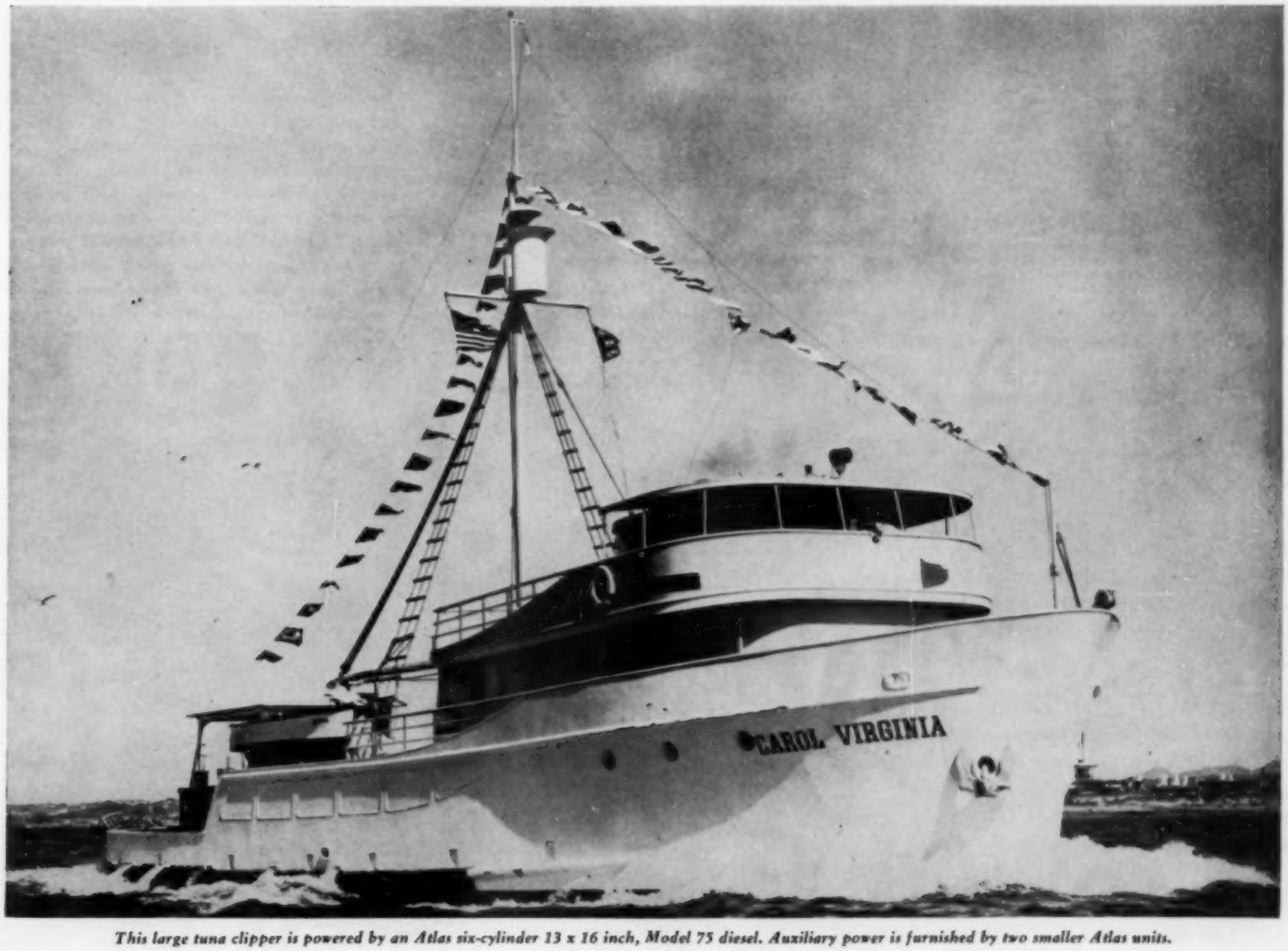
CIRCULATING WATER PUMPS—For stationary engines, jacket water and raw water pumps can be furnished as extra equipment when required; of centrifugal type, either V-belt or gear driven from engine, or with independent motor drive. For Model 45 marine propulsion engines, dual centrifugal engine driven pumps usually are provided for jacket water and raw water, respectively. Model 35 has V-belt driven pumps for marine or stationary applications.

AIR COMPRESSOR FOR MODEL 45 MARINE ENGINE—A Quincy or equal air-cooled air compressor is used, mounted on the manifold side of the engine and belt driven. On direct reversible engines centrifugal unloading is provided to relieve the belts from overload when the engine is started during maneuvering. If so ordered the compressor can be provided with automatic pressure unloaders which function when a predetermined pressure has been reached in the air tanks.

MANEUVERING GEAR FOR MODEL 45 MARINE ENGINE—A pneumatic type maneuvering arrangement is standard for direct reversible marine engines, operated by means of a single lever at forward end of the engine. The system has interlocks to insure dependable operation.



Atlas turbocharged heavy duty, enclosed type, slow speed engine, Model 76-X.



This large tuna clipper is powered by an Atlas six-cylinder 13 x 16 inch, Model 75 diesel. Auxiliary power is furnished by two smaller Atlas units.

REDUCTION GEAR FOR MODEL 45 MARINE ENGINE—All model 45 reversible engines are equipped with reduction gears allowing the propellers to run at a slower, more efficient speed. With offset gear, the standard reduction ratio is 2:1; however, the eight-cylinder supercharged engine with offset gear may be equipped with 2.71:1 reduction if so required. The construction is extremely rugged and compact. The propeller shaft is offset below engine crankshaft, and the shaft rotation is opposite to the engine rotation. Right-hand rotation of the propeller shaft is standard. Anti-friction type thrust bearings are inbuilt in all gears. With in-line gear, the standard speed ratio is 2½:1 for supercharged reversible engine and 2:1 for non-reversible engine.

SAILING CLUTCH FOR MODEL 45 MARINE ENGINE—When so ordered a sailing clutch can be incorporated in the offset reduction gear on direct reversible engine. This clutch is operated pneumatically from the starting air system and lends itself easily to pilot house operation.

REVERSE AND REDUCTION GEARS FOR MODEL 45 MARINE ENGINES—On the non-reversible marine engines reverse-reduction gears are used. The gear construction is extremely rugged and compact. The standard 2:1 ratio reduction is built right into the unit with the centerline of the propeller drive shaft in line with the engine crankshaft.

Two specially designed wet type clutches control the ahead and astern rotation in the reverse gears and are operated hydraulically.

The reverse gear is operated by means of a single control lever conveniently located on the top of the gear case, making it simple to connect the operating lever to a pilot house control station. In all cases, anti-friction type thrust bearing is inbuilt in the reverse-reduction gear.

MODEL 35 MARINE ENGINES: As this is a single rotation engine, a standard selection of reverse-reduction gears is offered—2:1 and 3:1, with 2.5:1 as additional choice for standard anti-engine rotation.

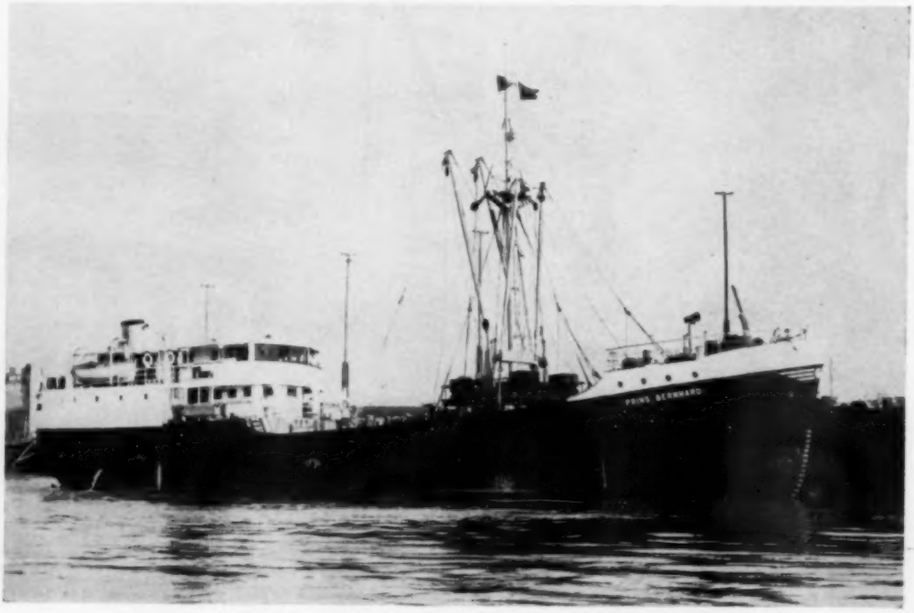
POWER TAKE-OFF AT FORWARD END OF MODELS 35 AND 45 MARINE ENGINES Provision, for optional power take-off, with or without clutch, is made at the forward end of the engine. When not required, the opening is closed by a suitable cover plate.

Newest San Diego Ferry, Diesel-Electric powered with slow speed Atlas Model 76-S-6 diesel engines.

Supercharged Model 35X and 45X

Supercharged models are equipped with a self-contained exhaust-driven turbocharger connected to the exhaust and air intake manifolds. This turbocharger consists of a gas turbine and centrifugal blower mounted on a common shaft, which supplies air to the intake manifold under pressure. Operation of the turbocharger is fully automatic at all speeds and loads, and no extra control devices are necessary.

Supercharging results in a substantially greater output from a given engine displacement, thus giving greater shaft horsepower with only small increase in engine size or weight. By supercharging, specific fuel consumption is reduced, particularly at partial loads. The supercharged models have established an outstanding performance record in heavy duty service in river towboats, fishing vessels, etc.; also in many modern industrial power plants, etc.



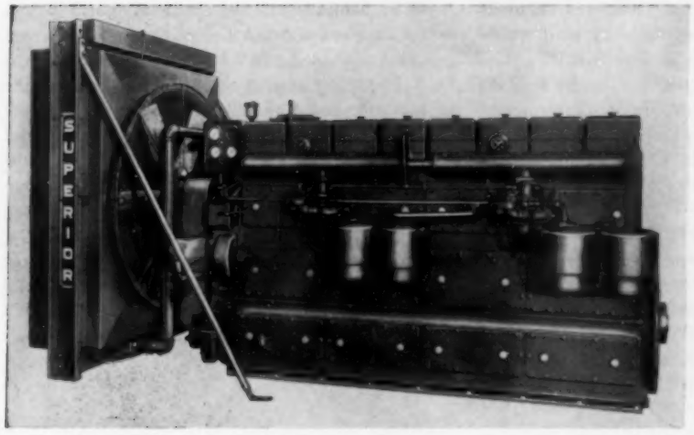
Motor vessel powered by ATLAS 45-M3X-8.

SUPERIOR GAS ENGINES

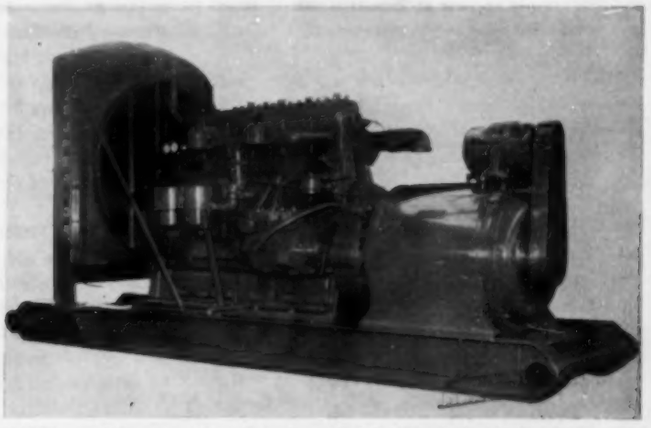
Built to the same high production standards as Superior and Atlas diesels these engines embody heavy duty construction and have high tension magneto and spark ignition. The fuel gas and air are mixed by carburetor or mixing valve with speed regulation by throttling valve linked to the governor on the engine. All models are of enbloc design with complete enclosure and pump pressure lubrication. Models G-825 and 80G have oil cooled pistons. Starting is by admission of compressed air to each cylinder at not over 250 psi., excepting that the 6G-510 engine has ring gear on flywheel for Bendix starter driven by hand-cranked gasoline engine (or to special order, by rotary air motor). Accessories and auxiliaries can be furnished to adapt these rugged and dependable engines for a great variety of applications. The horsepower ratings are based on natural gas of approximately 1000 Btu. per cubic foot, L.H.V.

Four Superior 6G510 gas engines provided power for a drilling rig in California which in 1953 set a new depth record for producing wells.

Model	Cycle	No. Cyls.	BHP.	RPM.	Bore	Stroke	Starting
6G-510	4	6	190-370	600-1200	8½	9	Ring gear, gasoline engine or air motor
6G-825	4	6	300-450	600-900	10	10½	Air
8G-825	4	8	400-600	600-900	10	10½	Air
80-G-6	4	6	600-780	300-375	14½	20	Air
80-G-8	4	8	800-1040	300-375	14½	20	Air

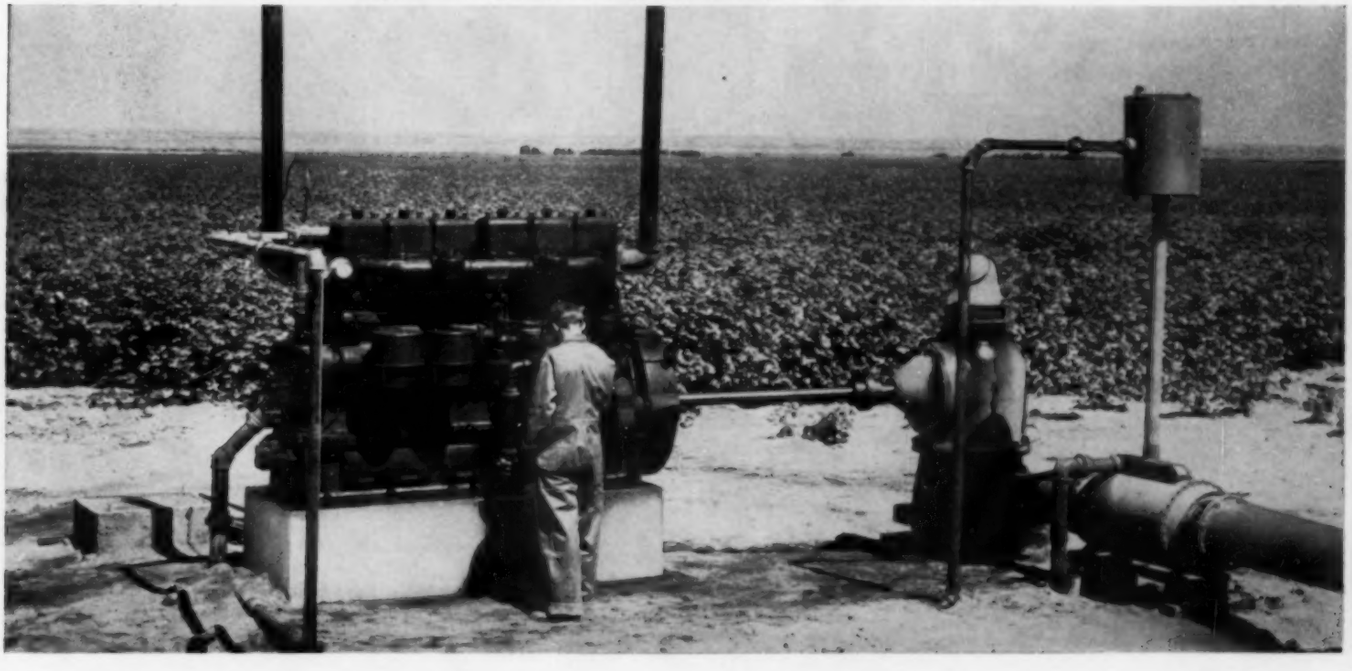


8 cylinder model, Superior G-825 gas engine in use on generator sets, drilling rigs and in other service.



Skid-Mounted Generator Sets: Superior and Atlas Diesel, dual-fuel and gas engine generator sets mounted on heavy welded structural steel foundation, are available in capacities from 60-KW. to 500-KW.

Superior 6G-510 gas engine driving vertical turbine pump in water well for irrigation.



INGERSOLL-RAND

TYPE "S" AND "SS"
TYPE "T" AND "TS"

INGERSOLL-RAND diesel engines are fully enclosed, solid-injection, single-acting units that operate on the four-stroke cycle. They are made in two cylinder sizes.

The "S" and "SS" engines have a bore of 10½ inches and a stroke of 12 inches. Built with 5, 6, 7 and 8 cylinders, the naturally aspirated "S" engine is rated at 375, 450, 525 and 600 horsepower. Turbo-charged "SS" engines are rated at 595, 715, 830 and 1000 horsepower. Both the "S" and "SS" engines operate at 720 rpm. for 60 cycle service and 750 rpm. for 50 cycle service.

"T" and "TS" models have a bore of 7 inches and a stroke of 8½ inches. They are built with 6 or 8 cylinders and rated at 200 to 380 horsepower at 900-1000 rpm.

Application

I-R diesels are heavy-duty continuous service engines applicable for driving generators, pumps, blowers and other types of equipment. They can be furnished for marine service and their relatively low weight and compactness makes them particularly suitable for skid-mounting.

Type S and SS Engines

COMBUSTION SYSTEM employs twin opposed spray nozzles, a characteristic common with the Price system which has long been associated with Ingersoll-Rand engines. The top of the piston is concave to form the bottom of the combustion chamber. The turbulence which is so necessary in the proper distribution of air and fuel for perfect combustion is accomplished by bringing the intake air into the cylinder through a nozzle shaped passage arranged tangentially to the cylinder. This produces a high velocity swirl within the cylinder and brings each minute particle of fuel injected through the nozzles into contact with the oxygen necessary for its combustion. Consequently, a very low fuel consumption can be guaranteed with a small variation in fuel economy between ¾ and full load operation.

FUEL INJECTION SYSTEM spray nozzles are of the single hole self-cleaning type. The use of two check valves in each nozzle cuts off injection instantly and prevents dribbling of the fuel into the combustion chamber or leakage of the gases back into the fuel piping. Each cylinder is served by an individual fuel injection pump which is located at the side of the engine just above the camshaft. Connecting lines between the pump and the nozzles are short and of the same length for each cylinder. The amount of fuel injected per stroke is regulated according to the load by a common control shaft actuated by the governor. In the event any single pump sticks, the control of the other pumps is not affected and the engine will continue under governor control and can be stopped in the regular manner.

FUEL SYSTEM provides for fuel oil pumped from the day tank and supplied to the injection pump under a slight pressure by a positive displacement fuel supply pump. This pump is located at the operating end of the diesel and is driven from the camshaft. Fuel oil is delivered through a series of filters and an air separator to the header for the injection pumps. At all times the supply pump provides more fuel than the injection pumps can possibly use. A relief valve on the top of the air separator chamber allows the surplus fuel to be returned to the tank. Since this relief valve is located at the top of the chamber, it also expels any air which may have entered the system.

FUEL ECONOMY of "S" and "SS" engines is

This 6-cylinder, 285-hp. Ingersoll-Rand "TS" diesel provides big engine design and performance in a smaller, lighter frame.

Eight-cylinder, 1000-hp. Ingersoll-Rand Type "SS" Turbocharged diesel engine.

sustained over years of operation. The low fuel consumption is accomplished without resorting to excessively high cylinder pressure or making frequent adjustments to the injection and combustion system components. Fuel consumption curve indicates little variation in economy in the region of ¾ load to full load.

LUBRICATING OIL SYSTEM employs a gear-type pump which is driven from the flywheel end of the crankshaft and takes suction through a strainer in the engine base which acts as an oil sump. The lubricating oil is then passed through an externally mounted cooler and filter and returned to the headers in the engine which supply all of the bearings, the various parts which require lubrication and the piston spray cooling system. Two relief valves are employed; one to protect the pump and the other to maintain proper pressure in the headers. The surplus oil drains back to the base and is recirculated.

Controlled lubrication of the cylinder walls is provided by two vented oil scraper rings on the piston skirt and one unvented ring above the pin. A bayonet type oil gauge projecting into the crankcase is used to determine the oil level.

The system is entirely automatic and requires no attention from the operator other than normal routine maintenance. Bypass valves function automatically in event of high oil viscosity due to low oil temperatures. An automatic shutdown device stops the engine when ever lubricating oil pressure becomes abnormally low.

COOLING WATER SYSTEM is specially designed to provide a high velocity flow where the engine parts are the hottest and thus where the greatest cooling effect is needed. The cooling water enters the engine through a header which is cast integral with the housing.

The cylinder liners are of the wet type and are freely set in the housing to allow the liners to slide upon expansion or contraction by the use of packing rings. The packing rings prevent water from leaking into the crankcase. An annular space between the bottom two rings is vented to the outside. This vent or "tell-tale" drain prevents water from seeping into the crankcase. It also indicates when the upper two rubber seal rings should be replaced.

A special rubber gasket and steel ring held in position by the cylinder head seals the upper end of the cylinder jacket water space which is divided into two separate annular spaces. The velocity of the cylinder jacket water increases as it flows upward through these two annular spaces and results in better heat transfer where it is needed most. The location of the cylinder liner supporting flange eliminates a heavy concentration of metal at the top of the cylinder liner and contributes to more efficient heat transfer.

The cooling water flows from the cylinder jacket space to the cylinder head through an externally mounted water jumper. Baffles, cast into the cylinder head, direct the flow of cooling water across the bottom of the head. The valve seats are thoroughly cooled and the water flows out of the top of the head into the water jacket of the exhaust manifold, which also serves as the water discharge header. A separate water discharge header is furnished when a supercharged engine is equipped with an insulated exhaust manifold.

A generous supply of water to the engine keeps the overall temperature rise at a minimum. The system gives good distribution of flow among the cylinders, provides high velocity cooling, eliminates hot spots and, in general, keeps the entire engine at pretty much the same temperature.

An automatic shutdown for high cooling water temperature is built into the engine. An alarm to give warning in advance of shutdown can be provided. The source of the cooling water may vary with the individual installation. A built-in Ingersoll-Rand recirculating pump can be furnished.

STARTING is by compressed air from a 250-lb. pressure supply. Valves in each cylinder head are opened and closed pneumatically, the timing being controlled by a disc type pilot valve driven from the camshaft. After the engine starts the check valve in each cylinder head prevents leakage back into the starting air line.

Air or electric cranking motors can also be used to start "S" and "SS" engines. Air cranking motors can be used with air pressures as low as 100 psi.

MECHANICAL DETAILS of design help to make "S" and "SS" engines compact and self-contained units that stand only 7 feet high. Quick and easy access to all of the working parts in provided and the usual service operations can be performed in a surprisingly short time.

The engine housing is a one-piece, high strength iron casting. Its deep girder section provides longitudinal stiffness thereby minimizing crankshaft deflection and prolonging bearing life. The cast iron base has a flat underside with wide foundation bearing flanges for easy handling both during shipment and installation. The engine base serves as the lubrication oil reservoir and for marine service a V sump is furnished.

The combustion forces are carried only by the long cylinder head studs, the main housing and main bearing studs. There is no problem in keeping the joint between the main housing and the base of the engine oil tight.

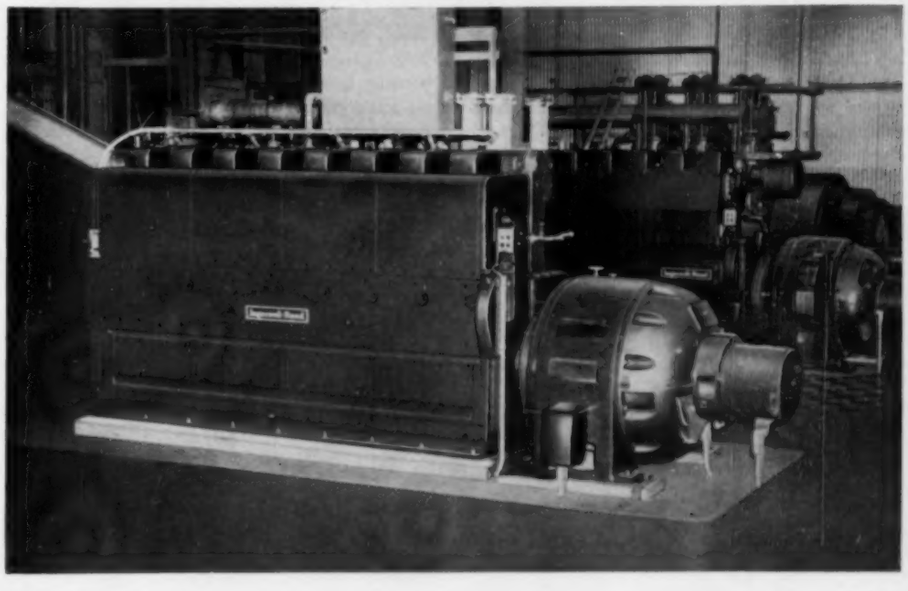
The exhaust manifold is a separate casting. It is bolted directly to the cylinder heads and the exhaust pipe can be attached to whichever end of the engine convenience dictates.

The crankshaft is a one-piece, heavy steel forging, carefully designed to avoid torsional vibration within the operating range. It is heat treated for strength, ductility and uniform hardness and is carried underslung with the main bearings secured to the underside of the housing. The diameter of the main journals provides large bearing surfaces and small bearing loadings. Bearing wear and loads are further minimized through the use of counterweights which also contribute to the general balance and smooth running qualities of the engine.

Main and crankpin bearings are solid aluminum alloy and are free to rotate and distribute the wear over the entire surfaces of both shells. Top and bottom halves of any bearing are interchangeable.

The lightweight aluminum pistons, which are spray cooled from the lubricating oil system, are carefully designed to retain their true shape under all conditions. They are fitted with five compression rings and three oil control rings. Piston pins are full floating and run in solid bronze bushings set in the connecting rods.

Two 8-cylinder Ingersoll-Rand diesels driving generators in a large brewery in Central America.



Key to Cutaway Drawing (Type "S")

1 *The valve mechanism is protected from dirt and grit by easily removable individual covers.*

2 *Positive displacement pump delivers fuel oil under pressure through an air separator and filter and on to the individual fuel injection pump at each cylinder.*

3 *The starting air distributor for admitting air to the cylinders in turn is enclosed. Air or electric cranking motors can be furnished if desired.*

4 *Connecting rod crankpin bearing assembly is secured by four bolts and is easily accessible through large crankcase openings.*

5 *Drilled passages in the crankshaft provide pressure lubrication to both main and connecting rod bearings.*

6 *Gear-type positive displacement lubricating oil pump is gear-driven from the flywheel end of the crankshaft.*

7 *Full floating piston pin is pressure lubricated through a drilled passage in the connecting rod.*

8 *Helical gears provide quiet and efficient operation of all auxiliary equipment at the flywheel end of the engine where torsional disturbances are at a minimum.*

9 *Oil scraper rings both above and below the piston pin give controlled lubrication of the cylinder walls.*

10 *Aluminum-alloy pistons are "dished" at the top to provide better turbulance . . . more complete, efficient combustion.*

11 *Water-jacketing with controlled high-velocity circulation of cooling water results in more efficient heat transfer.*

12 *Individual fuel injection pump for each cylinder controlled by a common shaft from the governor.*

13 *Renewable guides are used for longer life and easier replacement when necessary.*

14 *Double springs on valves keep the valve gear in contact with the cam at all speeds.*

15 *Two single-hole non-clogging fuel injection nozzles serve each cylinder.*

16 *Inlet-air manifold is integral with the housing thus improving the appearance of the engine and increasing rigidity of the housing.*

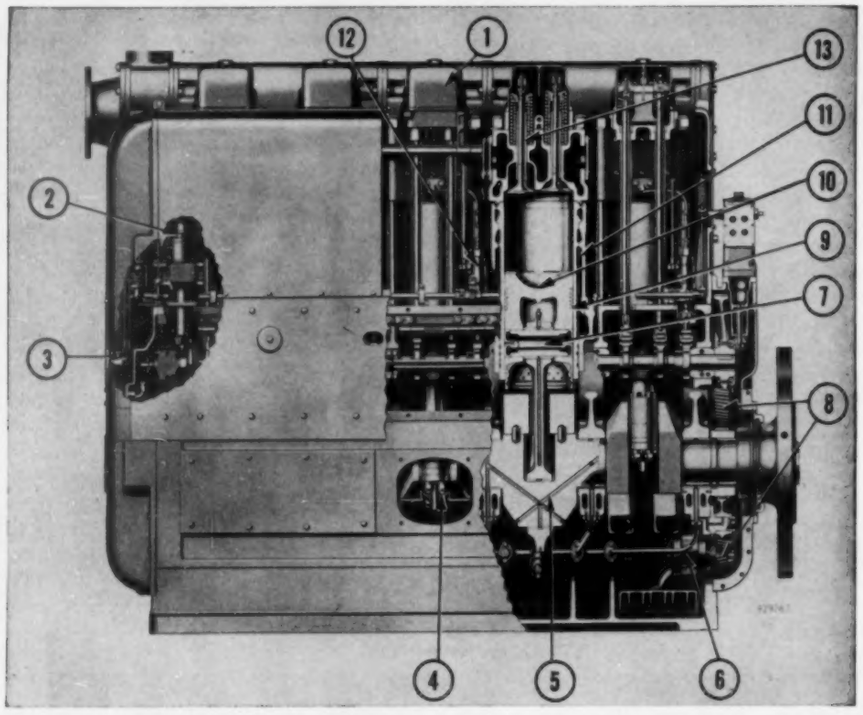
17 *Piston underside is spray cooled by oil carried through a drilled passage in the connecting rod.*

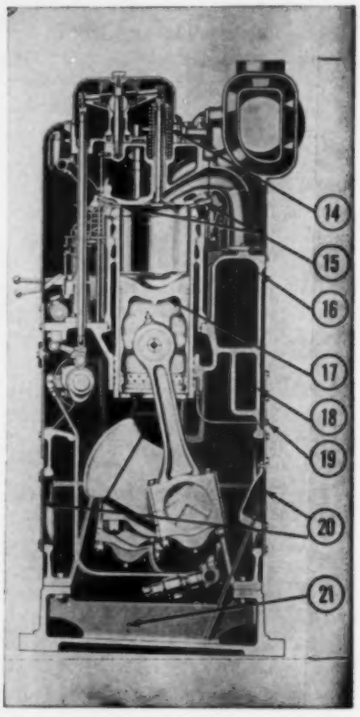
18 *Cast-in full-length water header distributes cooling water to each cylinder.*

19 *"Tell-tales" for each cylinder give warning of water leakage past the liner seals.*

20 *Removable covers permit unusually good accessibility of all the working parts.*

21 *Flat bottom base makes installation easier.*





The connecting rods are die forged stel, heat treated for hardness. They are rifle drilled for lubrication of the piston pin and spray cooling of the piston. The crankpin bearing cap is secured to the connecting rod by four bolts.

The overhead valves have long replaceable guides. The rocker arm mechanism is completely enclosed within easily removable covers. Push rods which are actuated from the camshaft are enclosed in tubes for added protection.

The camshaft, governor, water pump and lubricating oil pump are driven by means of a gear train at the flywheel end of the engine where torsional disturbances are at a minimum. The gears are of the helical type for quietness.

TURBOCHARGING by the Buchi system as used on the Type SS engine consists of a compact exhaust driven turbo-blower that delivers air under pressure to the engine cylinders. The pressurized air scavenges hot exhaust gases from the cylinders leaving less heat to be absorbed by the cooling water. Exhaust gases are then replaced with a fresh charge of high density air thus permitting the combustion of more fuel and resulting in higher output than an unsupercharged engine of the same displacement. Operation of the turbocharger is entirely automatic. The fuel consumption of the SS engine is extremely low in the normal operating range of our average power plant.

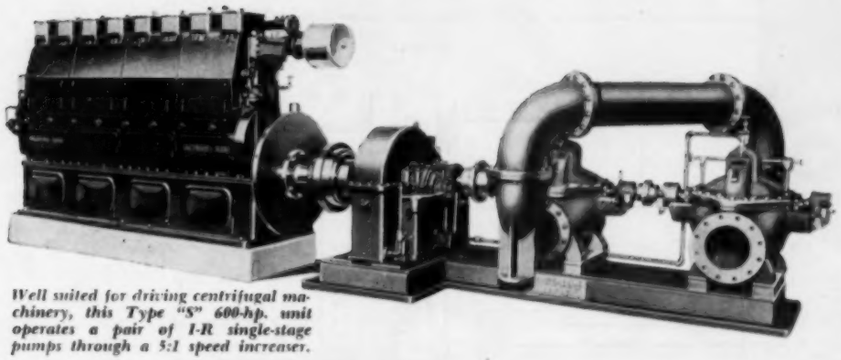
Type "T" and "TS" Engines

COMBUSTION SYSTEM for "T" and "TS" engines is similar to the system employed on the larger "S" and "SS" engines. Twin opposed spray nozzles, specially shaped air intake passages and concave piston top are used to provide the rotational turbulence necessary to effectively mix the air and fuel to produce complete combustion.

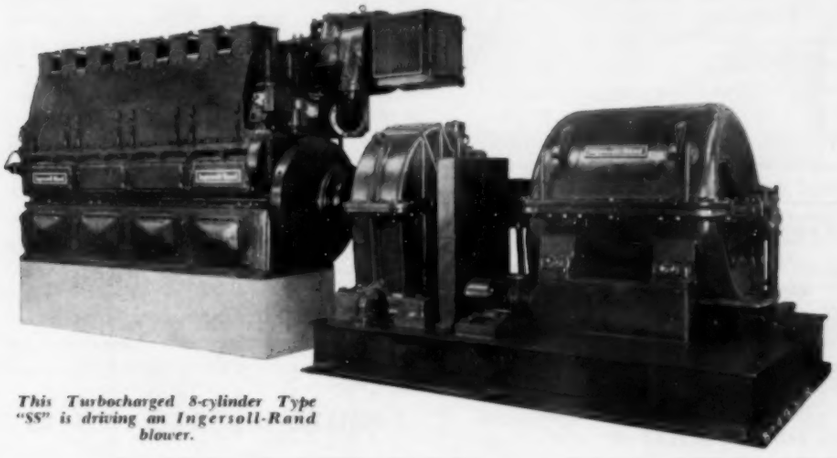
FUEL INJECTION SYSTEM is highly developed and features two opposed single hole non-clogging nozzles for each cylinder and individual fuel injection pump for each cylinder. The system includes fuel oil supply pump and attached duplex fuel oil filter of the absorbent type.

FUEL ECONOMY . . . The system results in unusually low fuel consumption for an engine of this speed and horsepower range. 0.40 lbs. of fuel per brake horsepower hour can be conservatively guaranteed at rated speed and output.

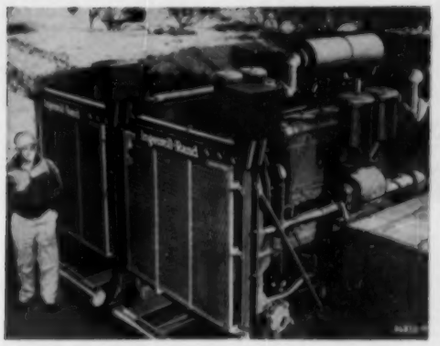
FULL PRESSURE LUBRICATION is provided through a gear-type pump located in the engine base. Oil is circulated through an edge-type strainer, oil cooler and bypass waste pack type filter before being supplied to all the parts requiring lubrication.



Well suited for driving centrifugal machinery, this Type "S" 600-hp. unit operates a pair of I-R single-stage pumps through a 5:1 speed increaser.



This Turbocharged 8-cylinder Type "SS" is driving an Ingersoll-Rand blower.



Two "TS" engines furnishing power on a rotary oil-well drilling rig. Each engine is rated a 285-hp.

HIGH VELOCITY COOLING . . . A gear-driven centrifugal pump circulates cooling water throughout the engine to provide efficient heat transfer. Bypass control insures correct engine temperatures which are maintained by radiator or heat exchanger. Motor-driven or built-in gear-driven raw-water pump of centrifugal-type can be furnished.

STARTING . . . Standard starting is by 250 psi. air admitted to all cylinders in turn by means of a starting air distributor. An Ingersoll-Rand air starting motor utilizing 100 psi. air or an electric motor can be furnished if desired.

MECHANICAL DETAILS . . . Standing only slightly more than five feet high, "T" and "TS" diesels embody all of the features essential to long life that are usually found only in engines with much larger horsepower. Their small comparatively light weight parts are easily serviced and inexpensively replaced when required. No special crane or hoisting equipment is required for maintenance work.

The frame is a rigid casting reinforced with heavy ribs and bearings on each side of every crank throw. It is oil and dust tight throughout. The main bearings are accessible through doors which are easily removed. There is no need to dismantle the engine to inspect or work on the bearings.

The diameter of the cast ferrous alloy crankshaft is considerably larger than is usual. This provides the stiffness, strength and durability that enables the "T" and "TS" engine to handle most any kind of job. The oil-type seal between the end cover plate and the crankshaft consists of two oil slinger rings and a felt ring.

Free floating main and crankpin bearings are solid aluminum alloy with double bearing surfaces inside and out. Main and crankpin bearings are interchangeable as are the top and bottom halves of any bearing. Connecting rods are drop forged steel, heat treated for long life and rifle drilled for lubrication of the piston pins. To permit the use of a maximum diameter crankpin and still allow the withdrawal of the connecting rod through the cylinder, the crank end of the rod is split diagonally.

Aluminum alloy pistons carry three compression rings and two oil control rings, one above and one below the piston pin, which is full floating and carried in a bronze bushing in the upper end of the rod.

Cylinder liners are of alloy cast-iron. They are the wet-type and are replaceable. The individual cylinder heads contain the overhead intake and exhaust valves. The rocker arm mechanism is automatically lubricated and is entirely enclosed within quickly removable covers.

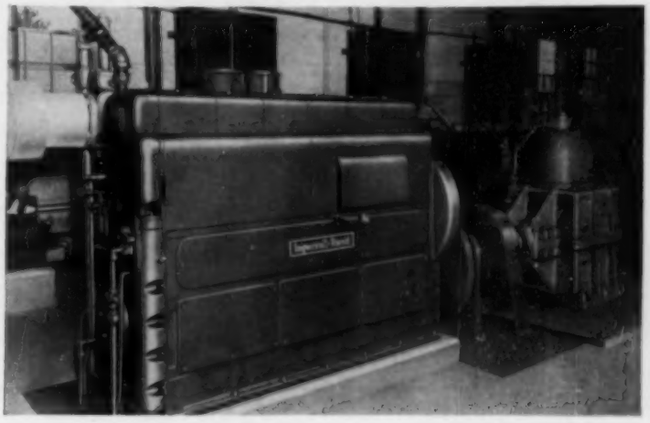
The standard governor is a mechanical fly ball type. Where close regulation is required or where parelleling with other alternators offer any problem, hydraulic relay type governors with variable speed droop can be supplied.

The camshaft, supercharger, water pump and lubricating oil pump are driven by means of a gear train located at the flywheel end of the engine where torsional disturbances are at a minimum. The crankshaft and engine covers are arranged so that power can be taken off the end opposite the flywheel as well as the flywheel end.

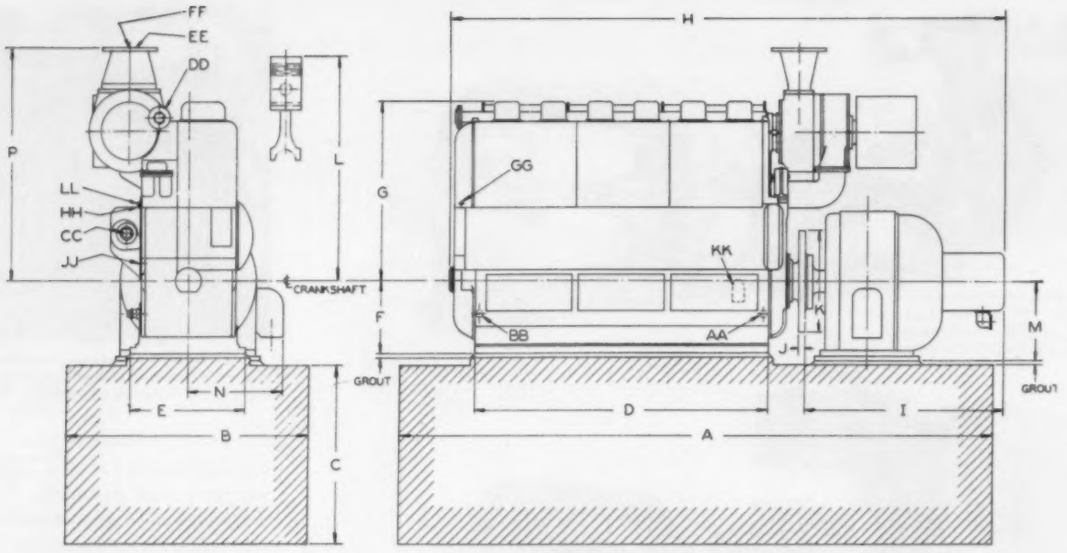
Automatic shutdown devices are provided in case of over-speed, high cooling water temperatures or low lubricating oil pressures. These prevent engine damage as a result of operating oversight.

SUPERCHARGING . . . The TS diesel engine is equipped with a gear driven mechanical supercharger which supplies air for scavenging the cylinders during the latter part of the exhaust and also for increasing the initial pressure in the cylinders.

This supercharging feature effectively cools the combustion chamber and admits more air to the cylinder so that more fuel can be burned with a resulting increase in power.

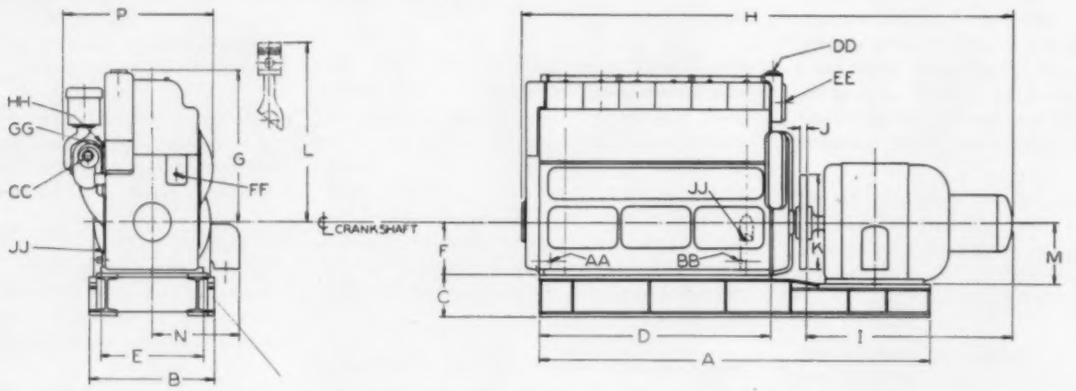


A 6-cylinder Ingersoll-Rand "TS" diesel driving an I-R vertical pump through right-angle gears.



Type	No. of Cyls.	Dimensions in Feet and Inches ("S" and "SS" Engines)														
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	P
S	5	17'-0"	7'-0"	5'-0"	7'-6⅝"	3'-4"	24⅜"	5'-0¼"	16'-4"	5'-10"	VARIES	2'-11"	6'-3"	2'-2¾"	3'-0"	
S	6	17'-0"	7'-0"	5'-0"	8'-6½"	3'-4"	24⅜"	5'-3"	16'-5"	5'-10"		2'-11"	6'-3"	2'-2¾"	3'-0"	
S	7	18'-6"	7'-0"	5'-0"	10'-1¾"	3'-4"	24⅜"	5'-0½"	18'-1"	6'-0"		2'-11"	6'-3"	2'-2¾"	3'-0"	
S	8	18'-6"	7'-0"	5'-0"	11'-2½"	3'-4"	24⅜"	5'-3"	19'-1"	6'-0"		2'-11"	6'-3"	2'-2¾"	3'-0"	
SS	5	17'-0"	7'-0"	5'-0"	7'-6⅝"	3'-4"	24⅜"	5'-0½"	15'-10"	5'-10"		2'-11"	6'-3"	2'-2¾"	3'-0"	6'-5¾"
SS	6	17'-0"	7'-0"	5'-0"	8'-6½"	3'-4"	24⅜"	4'-11¾"	16'-2"	5'-10"		2'-11"	6'-3"	2'-2¾"	3'-0"	6'-0⅜"
SS	7	18'-6"	7'-0"	5'-0"	10'-1¾"	3'-4"	24⅜"	5'-0½"	18'-1"	6'-0"		2'-11"	6'-3"	2'-2¾"	3'-0"	6'-5¾"
SS	8	18'-6"	7'-0"	5'-0"	11'-2½"	3'-4"	24⅜"	4'-11¾"	18'-10"	6'-0"		2'-11"	6'-3"	2'-2¾"	3'-0"	6'-5¾"

Dimensions are approximate only—Do not use for foundation purposes.



Type	No. of Cyls.	Dimensions in Feet and Inches ("T" and "TS" Engines)														
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	P
T	6	8'-3"	3'-6"	12'	5'-9¾"	2'-8"	15¼"	3'-9⅞"	12'-8"	5'-2⅞"	VARIES	2'-8"	4'-5"	1'-6⅝"	2'-2⅝"	3'-11"
TS	6	8'-3"	3'-6"	12'	5'-9¾"	2'-8"	15¼"	3'-9⅞"	12'-8"	5'-2⅞"		2'-8"	4'-5"	1'-6⅝"	2'-2⅝"	3'-9"
TS	8	10'-1"	3'-6"	12'	7'-7¾"	2'-8"	15¼"	3'-9⅞"	15'-8"	6'-2"		2'-8"	4'-5"	1'-8"	2'-5¾"	3'-9"

Type	Cycle	Hp.	Cyls.	Bore	Stroke	R.P.M.	Fuel System	Stationary	Marine	Starting
T	4	200	6	7	8½	900-1000	Own	Yes	Yes	Air or Electric
TS**	4	285	6	7	8½	900-1000	Own	Yes	Yes	Air or Electric
TS**	4	380	8	7	8½	900-1000	Own	Yes	Yes	Air or Electric
S	4	375	5	10½	12	720- 750	Own	Yes	Yes	Air or Electric
S	4	450	6	10½	12	720- 750	Own	Yes	Yes	Air or Electric
S	4	525	7	10½	12	720- 750	Own	Yes	Yes	Air or Electric
S	4	600	8	10½	12	720- 750	Own	Yes	Yes	Air or Electric
SS*	4	595	5	10½	12	720- 750	Own	Yes	Yes	Air or Electric
SS*	4	745	6	10½	12	720- 750	Own	Yes	Yes	Air or Electric
SS*	4	830	7	10½	12	720- 750	Own	Yes	Yes	Air or Electric
SS*	4	1000	8	10½	12	720- 750	Own	Yes	Yes	Air or Electric

* Turbocharged. **Supercharged

ALCO PRODUCTS

ALCO Products, Inc. (ALCO) manufactures a complete line of four-cycle, medium-speed diesel engines—either in-line or vee type—with a range of 550 to 2400 horsepower. (1) These engines are available as portable diesel power package units—565, 975, 1130, 1300 and 1520 kw—complete with all equipment necessary for generating or pumping service. ALCO has developed a complete diesel-electric oil well drilling rig, which includes engines, generators, motors, pumps and control panels and equipment, and is adaptable for either land or off-shore drilling.

ALCO diesel engines can be provided for dual-fuel operation merely by adding parts and not by redesign or rebuilding. Turbocharging is another feature. All turbocharged ALCO diesels are equipped with a new-design turbo-supercharger that has the highest efficiency of any tested, has considerably fewer parts than turbochargers previously available and is easier to clean and repair.

12 1/2 x 13-INCH MODEL

GENERAL ARRANGEMENTS: The engine arrangement consists of a substantial base of reinforced box-section extending the length of the engine. It forms rigid supports for the main bearings, engine mounting rails and lubricating oil sump. The cylinder block rests on the base and forms the water jackets for the power cylinders as well as space and supports for the camshaft and its bearings. The engine is completely enclosed including the valve gear, and vital parts are easily accessible for maintenance. All moving parts are provided with automatic forced-feed lubrication.

ENGINE BASE: The engine base is of cast semi-steel, with reinforcements for strength, and provided with bearing seatings accurately bored in line with each other to receive the main bearing shells. This insures their perfect alignment at all times and facilitates the removal of a bearing shell. The base is provided with a flange or mounting rail along each side for fastening the engine to its foundation. For locomotive engines a drop center, or high-mounting-rail type of base design is used to effect a low locomotive silhouette for visibility purposes. The stationary engine versions usually use a flat-bottom base design. The base is provided with large openings on each side opposite the crank pins. These are fitted with quickly removable covers to permit easy access to the rotary parts. The lower part of the base serves as the lubricating-oil sump.

CYLINDER BLOCK: The cylinder block is of cast semi-steel and is arranged to form the cylinder water jackets. The block is fitted with removable cylinder liners and is also provided with studs in the top surface for attachment of the individual cylinder heads. Water space is of ample volume and the design attains uniform, thorough, full-length cooling of the cylinder and proper water flow to the cylinder heads. As a casing for the camshaft and the valve push rods, the cylinder block serves to keep them completely enclosed during normal operation, yet quickly accessible for maintenance through removal of the side covers.

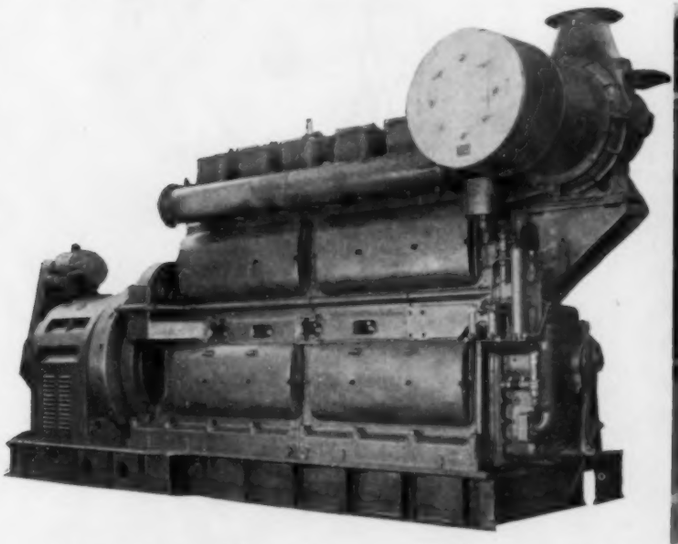
CYLINDER LINERS: Cylinder liners for these engines are made of a close-grained alloy cast iron. They are fitted into the cylinder block at the top and held securely at the end by the cylinder head, leaving the lower end free to expand and contract with changing temperatures. The water joints are sealed with rubber "O" rings. The final finish of the liner bores is honed.

CRANKSHAFT: The crankshaft is machined from a one-piece open-hearth steel forging. It has one throw for each power cylinder and a main bearing of ample area at each end and between each two cylinders. The shaft is drilled for full-pressure lubrication. The driving end contains a large flange for power transmission and a split gear for camshaft drive.

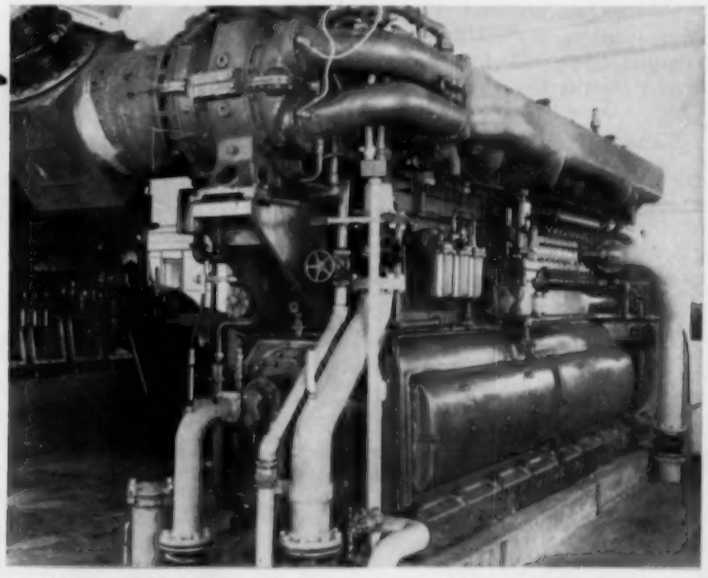
PISTONS: The engine's pistons are trunk-type with concave heads. They are made of aluminum alloy or close-grained cast iron, and may be of the dry type or oil-cooled according to the type of service. They have a full-floating type piston pin, with end plugs providing a block to lubricating-oil leakage. Four compression and three oil-control rings (one above and two below the piston pin) are used. Life of the aluminum pistons is greatly extended by use of a *replaceable* compression-ring carrier.

CYLINDER HEADS: Cylinder heads are made of high strength close-grained, stress-relieved alloy cast iron. The heads contain two air valves and two exhaust valves arranged around the centrally located

(1) Alco diesels are also manufactured in Canada.



ALCO 6-cylinder, 12½ inch by 13 inch stationary engine, rated at 810 bhp at 600 rpm.



Any ALCO diesel can be equipped for dual-fuel operation, and all turbocharged diesels have the new water-cooled ALCO turbo-supercharger, with the highest efficiency of any tested.

fuel-injection valve. The heads contain ample water jacketing. The pressed-in valve guides are replaceable and insert-type valve seats are available. In applications requiring air starting an air-starting valve and a safety valve are fitted into the head. For dual-fuel operation a patented gas-metering valve is also added to the head. Each head is provided with an indicator connection. The valve gear is totally enclosed and full-pressure lubricated.

CONNECTING RODS: Connecting rods, and crank-pin bearing caps, are made of drop-forged open-hearth alloy steel. The caps are secured to the rods by bolting. The rod body is rifle-drilled for forced-feed lubrication to the piston pins, and, if required, for piston cooling. The crank ends have split bushings, bronze-backed and babbit-lined, accurately bored and precision fitted for easy replacement. The piston-pin end of the rod contains a one-piece bronze bushing for the full-floating pin.

CAMSHAFT and GEARS: The integral-cam camshaft is made of heat-treated steel, accurately turned and ground to size. It is driven from the crankshaft by a forged alloy-steel single-helical type gear train of large diameter and ample face. The camshaft and gear-train bearings are force-feed lubricated.

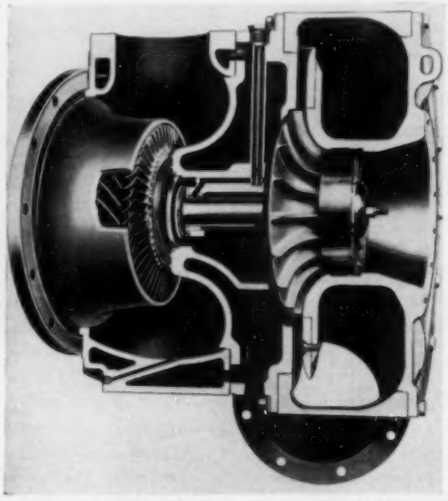
FUEL INJECTION SYSTEM: A single-acting plunger pump, individual for each cylinder, supplies the fuel. Fuel flow to the engine is controlled by a governor of suitable design for the service intended, to maintain speed at whatever load the engine is carrying. Means are provided for cutting out any or all pumps. The pumps are located at a point mid-length on the engine on the opposite side from the air and exhaust camshaft, but they are driven by the same gear train. This design allows easy accessibility and adjustment. All engines are equipped with a mechanical overspeed safety trip on the fuel camshaft. This locks out the fuel pump "X" head in case of governor malfunction.

LUBRICATION: All moving parts, including the turbocharger, are lubricated by a single-pressure system consisting of a rotary-type pressure pump located at the free end of the engine, and driven by the crankshaft. Flow from the pump is through a built-in engine strainer, through the cooler and then to distribution piping.

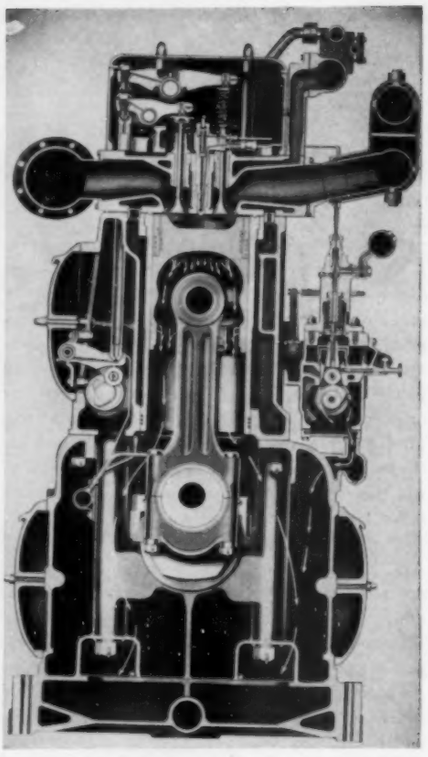
COOLING WATER: Circulation of cooling water is accomplished by a centrifugal pump. This may be driven either by the camshaft gear train or by a separate motor drive. Circulation goes first to the cylinder block, then through the cylinder heads to the outlet header and water-cooled turbocharger. Water-cooled exhaust manifolds are available when specified.

STARTING SYSTEMS: On stationary engines starting is accomplished by compressed air, admitted to the cylinder-head starting valves by the air distributor at the end of the fuel-pump camshaft. For locomotive service starting is accomplished by the traction generator, taking current from the storage batteries.

TURBOCHARGING: Each turbocharged engine is equipped with an ALCO-design water-cooled exhaust-driven turbocharger. The unit is totally enclosed. The casing is made of two sections, bolted and keyed together. Rotating parts are accurately balanced, both statically and dynamically, as well as being subjected to a severe shop overspeed test. The unit is designed to require a minimum of attention and to afford easy maintenance and repair.

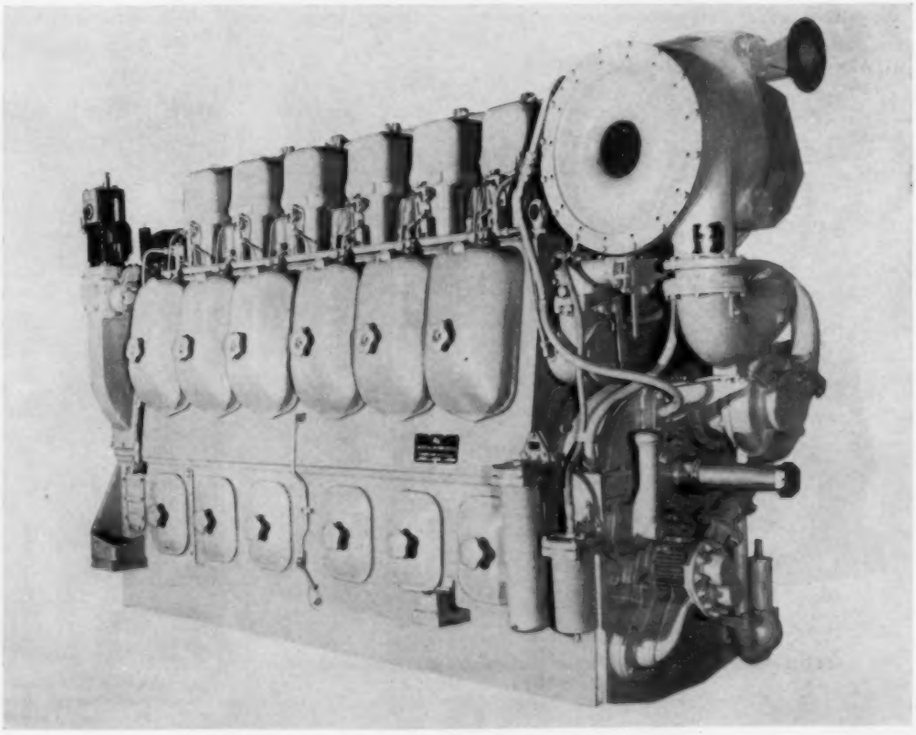


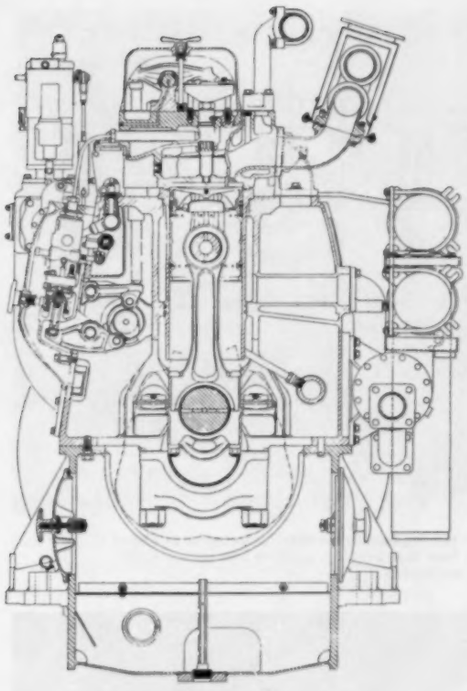
Cutaway drawing of ALCO 710 water-cooled turbosupercharger. Fewer parts and fewer points of critical clearance substantially reduce time required for maintenance. The ALCO 710 is more efficient than any other turbocharger tested.



Transverse section of Alco 12½ inch by 13 inch, 4 cycle Diesel engine.

ALCO 9 inch by 10½ inch six cylinder engine for stationary or portable service.





ALCO 6 cylinder 9x10½ engine.

9x10 1/2-INCH MODELS

These engines are designed for exacting demands of continuous or standby power supply for oil-well drilling rigs, pipeline pumping, electric-power generation, irrigation pumping, dredging, portable power package units for mounting on skids, trailers or rail cars, marine propulsion and railway service.

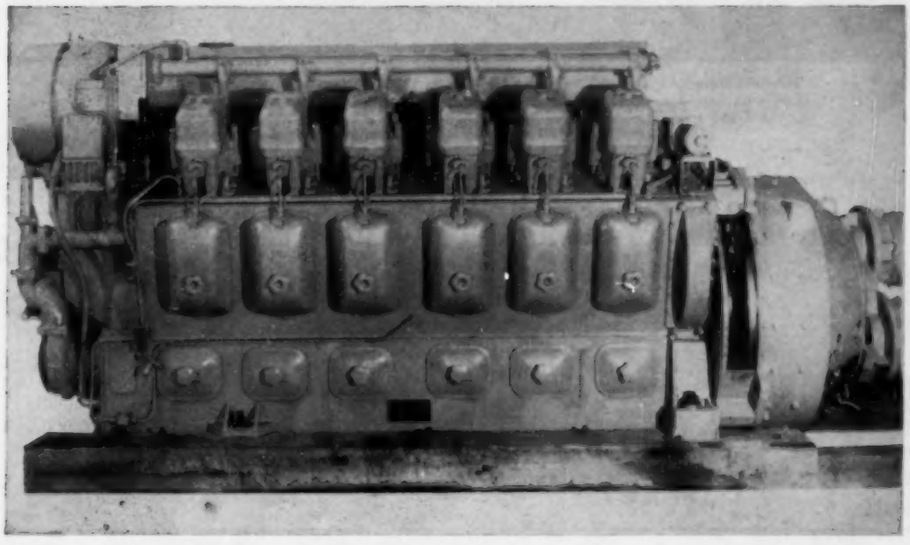
GENERAL ARRANGEMENT: A substantial welded-steel base extends the entire length of the engine. The welded-steel cylinder block which contains the power cylinders rests on the base. The structural steel base and frame combine lightness and strength which permits operation on light, economical foundations. The ALCO four-point mounting arrangement does not require the exacting and expensive grouting operation required with conventional or rail-type mounting. Each power cylinder has its own fuel-injection pump and injection nozzle. Full force-feed lubrication is used through the engine and turbocharger.

BASE: The base is made of welded steel embodying reinforcements which provide strength and rigidity to the engine. The base is provided with large openings on both sides opposite the crank pins. Quickly removable aluminum covers allow free access to the connecting rod and main bearings. The lubricating oil sump is in the lower part of the base and contains the built-in lubricating-pump suction header. Fine mesh screens are provided to prevent foreign material from dropping into the sump. Four supporting brackets are provided for foundation mounting purposes. A deep-sump base is provided for marine applications to give positive lubrication to the engine under 15-degree inclination and list conditions.

CYLINDER BLOCK: The cylinder block is of welded-steel construction and forms the main structural member of the engine. The main-bearing saddles are of drop-forged steel and form an integral part of the block weldment. The main-bearing seatings are accurately line-bored for use of precision, steel-backed bearing shells. The main-bearing caps are also drop-forged and are fitted by means of serrations, then bolted to the cylinder block. Cylinder liners are removable. The blocks are made in-line for the 6-cylinder engine and 45 degree Vee for the 12- and 16-cylinder engines. The block designs are such that no separate air manifolds is required.

CYLINDER LINERS: The cylinder liners are made of high-strength, close-grained, electric-furnace iron, heat-treated to relieve casting stresses. They are plain cylindrical castings fitted into the cylinder block and held securely at the top end of the cylinder heads leaving the other end free to expand with changing temperatures. "O" ring gaskets in grooves at the lower end of the liner seal against water leakage into the crankcase.

ALCO 12 cylinder 9x10½ Model 251 engine.



CRANKSHAFT: The crankshaft is an alloy steel forging, heat-treated to produce a suitable hardness. It is precision-machined to allow interchangeable main and connecting-rod bearings. A flange is provided at the driving end for power-transmission medium connection. This end also contains the split-camshaft drive gear. The shaft is drilled for full force-feed lubrication of all bearings. It is provided with necessary counter weights for smooth operation. The top ring groove is equipped with a ni-resist insert to improve ring land life.

PISTONS: Engine pistons are of the forged-aluminum type, accurately machined to give the proper clearance on the cylinder walls. Passages permit the piston cooling oil to enter the cooling space. Compression ring carriers may be replaced when necessary.

CYLINDER HEAD: Heads are made of high-strength, close-grained, stress-relieved cast iron. Two air and two exhaust valves are symmetrically arranged around each centrally located fuel-injection valve. Each head is provided with a passage and tapped hole for indicator cocks and with stellite valve-seat inserts. The air and exhaust valves are completely interchangeable and reciprocate in replaceable cast-iron guides. The valves are bi-metallic design.

CONNECTING RODS: Rods are of high-grade open-hearth drop-forged steel. Crank ends have drop-forged steel caps held to the connecting rods by four bolts. Crank ends have precision-type bearing shells. The rods are rifle-drilled to provide passage for the lubricating oil to the piston pin, and for cooling of the piston. The piston-pin end of the rod contains a one-piece bronze bushing for the full floating pin.

CAMSHAFT and GEARS: The camshaft is made of alloy steel, heat-treated and ground accurately to size. The cams are formed integral with the shaft which is made up in sections for each two cylinders. The camshaft, or camshafts, depending on engine size, is driven from the crankshaft by forged-steel, heat-treated, single-helical type gear train of large diameter and face.

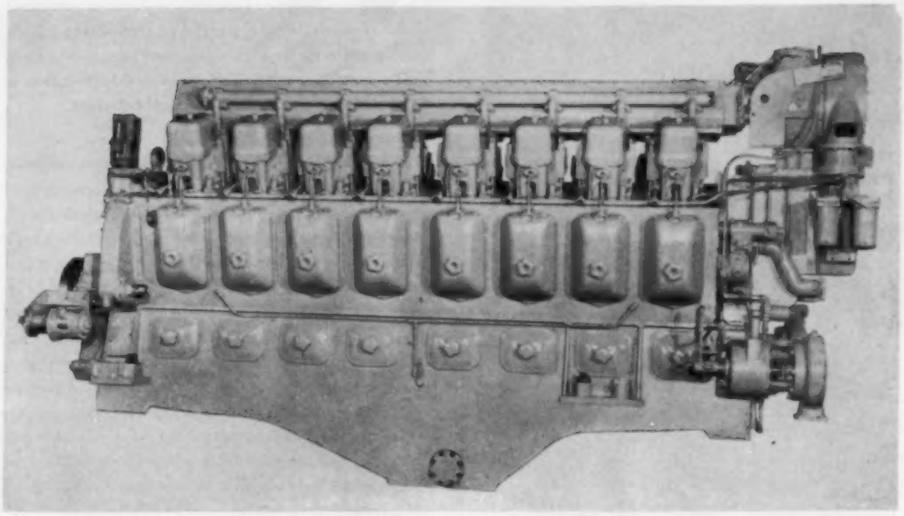
FUEL INJECTION SYSTEM: A single-acting plunger pump, individual for each cylinder, supplies the fuel. The pumps are readily accessible and removable. The amount of oil fed to the engine is controlled by a governor of suitable design for the service intended, so that only sufficient oil is fed to maintain the required engine speed at whatever load the engine is carrying. Means are provided for cutting out any or all pumps. Engine-mounted primary and secondary fuel filters are provided, and an engine-driven fuel booster pump is among the optional equipment available. A mechanical overspeed trip is provided which returns the fuel-pump racks to no-fuel position in case of governor malfunctioning. An electrical overspeed system is also available for use in certain railroad applications using special railroad electro-hydraulic governors. A separate cored passage for the injection tube prevents any possibility of fuel dilution of lube oil. Fuel oil from the pump cannot dilute lube oil in the event of broken fuel lines because the engine has a separate chamber, isolated from the camshaft, rocker levers and push-rod area.

LUBRICATION: A full force-feed lubrication system is provided for all moving engine parts and the turbocharger. This is done by means of a gear-type pump located at the free end of the engine base and driven by the accessory gear train. Oil from the pump passes through a safety valve, filter, cooler, pressure regulating valve and a fine-mesh screen basket before entering the main-bearing supply header and other engine distributing systems.

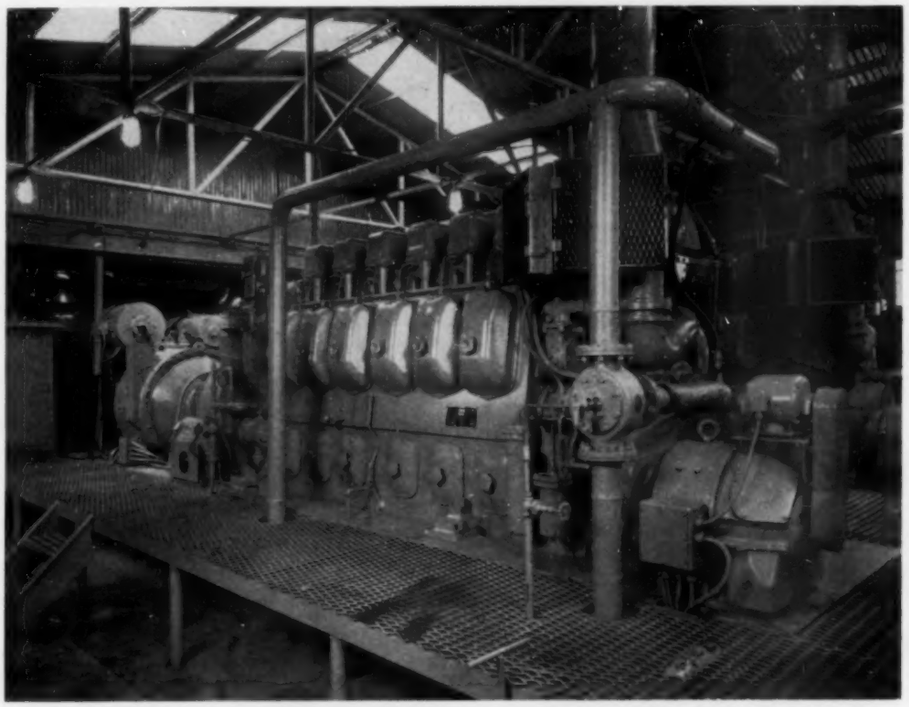
COOLING WATER: Circulation of cooling water is accomplished by a centrifugal-type high-capacity pump mounted and driven by the free-end accessory gear train. Circulation goes first to the cylinder block, up around the liners, into the cylinder head, and into the outlet header and water-cooled turbocharger. Water-cooled manifolds are available when specified. For marine service, the model 251 engine is equipped with a bronze engine-drive salt-water pump to circulate salt water to a shell-and-tube jacket-water cooler.

ENGINE STARTING: The engine is equipped with an air-starting motor driving through an automatic engaging drive and ring gear on the fly wheel, similar in principle to an automotive starting arrangement, and operating on a maximum starting air pressure of only 150 psi. The engines will start with less than 80 psi air pressure under normal conditions, thereby alleviating any necessity for high pressure air bottles or special air compressors. For locomotive service starting is accomplished by the traction generator taking current from the storage batteries. All engines in the 9x10½-in. series are equipped with a viscous-type vibration damper and a crankshaft extension at the free end for driving auxiliary equipment such as an air compressor, radiator fan, etc. For marine service, the engines are provided with opposite rotation in all three sizes. Dual fuel is available in all engines and spark ignition is being offered in the 9x10½-in. series.

TURBOCHARGER: A modern ALCO-designed and built water-cooled turbocharger is mounted on and made an integral part of the engine. It consists of a single-flow, single-stage centrifugal blower driven by an exhaust-gas turbine assembled in a single compact unit. Where applications warrants, an aftercooler is used.



A 16-cylinder, model 251-B Alco engine adapted for marine service. This engine produces 2100 bhp at 1,000 rpm. Note the deep-sump base that provides positive lubrication under 15-degree inclination.



The 6-cylinder Alco model 251-B engine forms the heart of the company's drilling rig power package for the oil drilling industry. In addition to two engines, which develop 850 hp at 1,000 rpm, the base rig consists of generators, one drawworks drive assembly, two mud-pump drive assemblies and complete controls.

TABLE
ALCO ENGINE SPECIFICATIONS

Model Bore and Stroke	Use	Cycle	No. Cyl.	Brake HP	Cont. RPM	Length In.	Width In.	Height In.	Weight Lb.
6-9x10-½-T	MSP	4	6	550-900	720-1000	136	60	88	22100
12-9x10-½-T	MSP	4	12	1100-1800	720-1000	158	61	95	32650
16-9x10-½-T	MSP	4	16	1470-2400	720-1000	197	61	96	42000
6-12-½x13	SP	4	6	580-660	600-740	156	60	82	34000
6-12-½x13-T	SP	4	6	810-1000	600-740	156	60	115	36000
8-12-½x13	S	4	8	775-860	600-720	200	60	96	49000
8-12-½x13-T	S	4	8	1080-1300	600-720	225	60	115	50000

M - Marine, S - Stationary, P - Portable.

INDUSTRIAL, AGRICULTURAL AND TRANSPORTATION TYPES

CONTINENTAL DIESELS

CONTINENTAL Motors offers 12 Diesel engine models for industrial and agricultural uses and four models for transportation applications The industrial and agricultural series, available in four-, six-, and eight-cylinder models, range from 34 to 202 hp, while the transportation engines range from 116 to 225 hp. All engines are four cycle and feature "Cushioned Power" combustion chamber, fully explained in fig. 1, 2, and 3.

Red Seal Diesels are correlated with their gasoline counterparts, having the same mounting dimensions and following the Continental pattern of maximum strength, without excessive weight, through the use of alloy materials. The Cushioned Power feature of the Diesel engine makes possible a wide interchangeability of parts with Continental's gasoline engines. Thus, engines using fuel oil, butane, gasoline or natural gas are interchangeable in any given type of application.

CYLINDER BLOCK and CRANKCASE are one-piece cast iron, heavily ribbed to prevent distortion and reduce vibration. Full-length water jacketing provides efficient cooling. Models GD-157, ED-201, ED-208, HD-243 and HD-260 have removable wet type cylinder liners. The SD-802, SD-6802, RD-572 and RD-6572 have dry cylinder liners. The TD-427, TD-6427, VD-603 and VD-8603 models have highly wear-resistant cast iron cylinders without liners.

CYLINDER HEADS are of one-piece cast iron for all engines except the RD-572, RD-6572, SD-802, RD-6802, VD-603 and VD-8603, which have a two-piece head. The latter engines, with combustion chambers with compression ratios of approximately 15 to 1 are of overhead valve type. The valve gear is enclosed on top of the engine by an easily removed, oil-tight sheet metal cover. Heads are held in place securely by a maximum number of studs, carefully placed to avoid cylinder distortion, and, at the same time, hold the cylinder head gasket in place, preventing leakage of compression and water.

CRANKSHAFT, carried underslung in the crankcase block, is dropforged steel with integral counterweight, and is statically and dynamically balanced. Main and crankpin journal surfaces are heat treated and Tocco hardened. Main bearings are

The "Cushioned Power" combustion chamber is shown in figures 1, 2, and 3. Figure 1 shows the turbulence chamber "B" and the energy cell "A" as seen from above. Figure 2 shows the beginning of ignition just before the piston reaches the top of its travel. A portion of the fuel is directed into the energy cell "A" where it is ignited and the peak pressure develops. The construction of the energy cell is such that it absorbs and stores these peak pressures momentarily preventing them from being transmitted directly to the bearings when the crank is near the top center. A moment later, however, as seen in figure 3 this high pressure is released on the power stroke through the metered opening of the energy cell making for a more effective use of the explosion force and producing a smoother flow of power.

Top Dead Center.

Figure 1

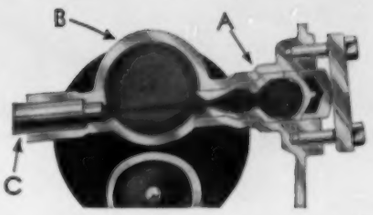


Figure 2

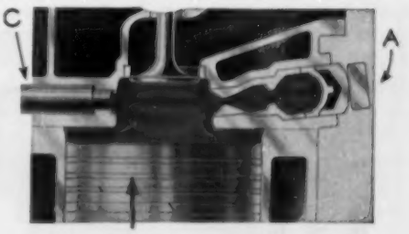
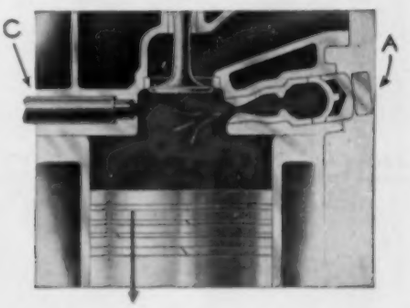
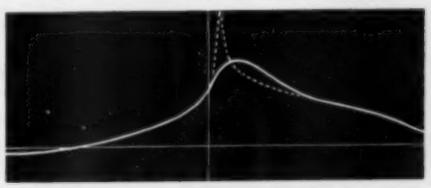


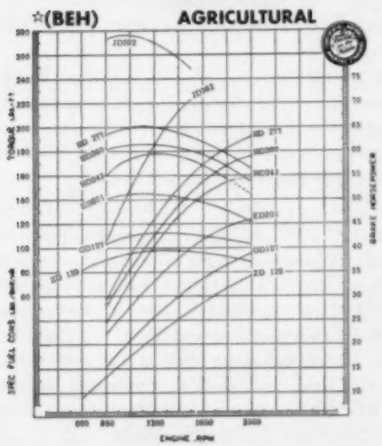
Figure 3



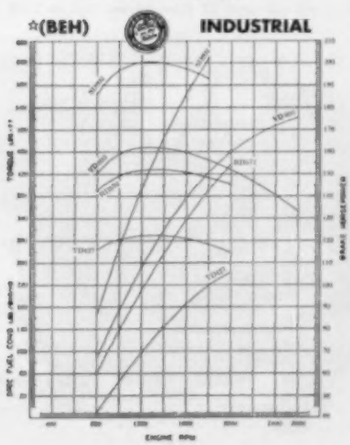
Diesel indicator diagram shows pressures developed in the cylinders of some typical Diesel engines (dotted line), compared to the solid line which shows the pressure curve of Continental's "Cushioned Power" Diesel. Note how the flatter curve of the Continental avoids dangerous peak pressures without losing power.



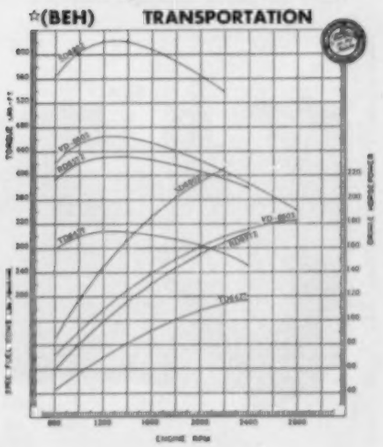
Bare Engine Horsepower Industrial Diesels

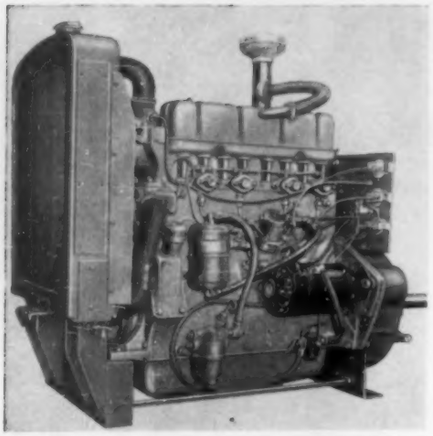


Bare Engine Horsepower Industrial Diesels

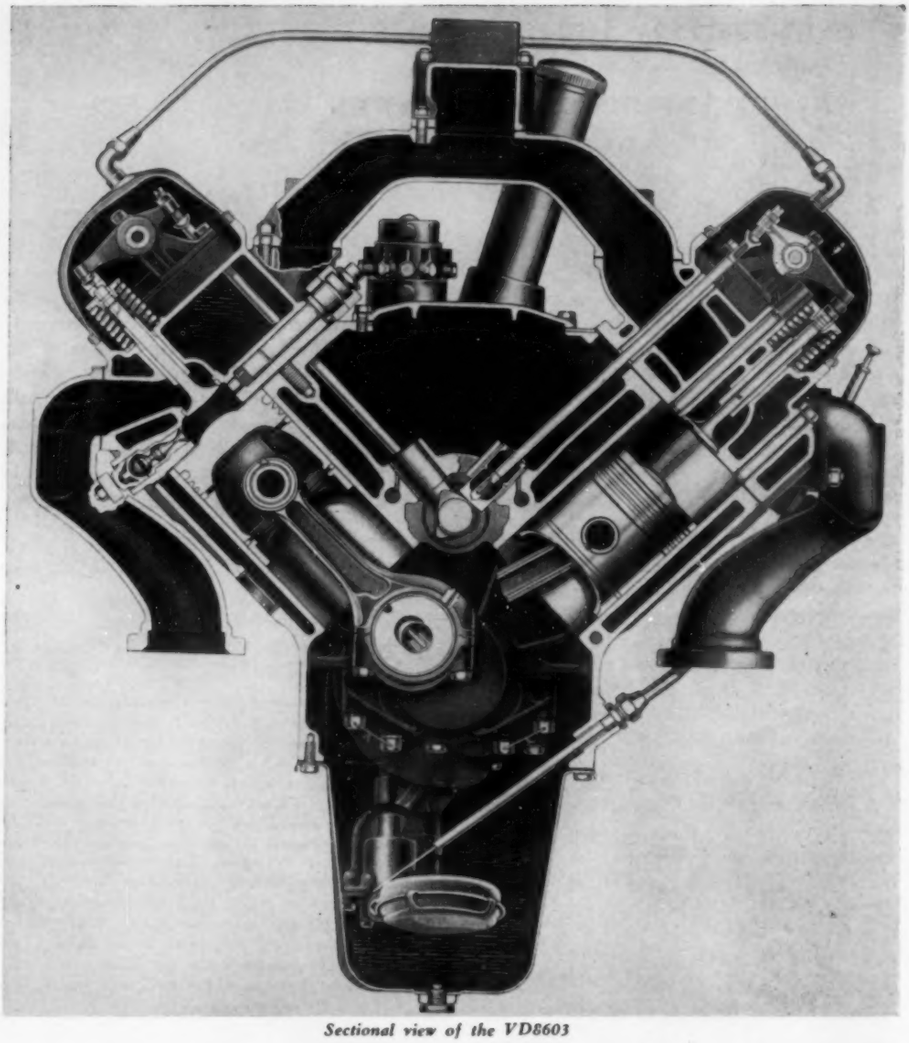


Bare Engine Horsepower Transportation Diesels

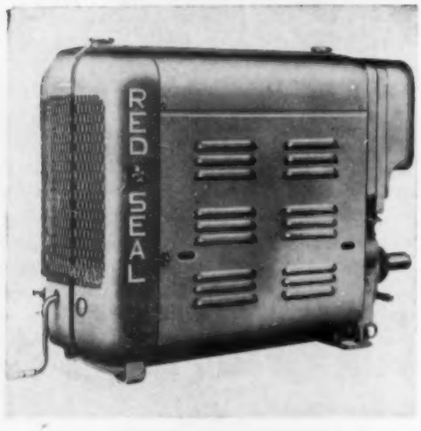




ED201 Cushioned Power Diesel Open Power Unit.



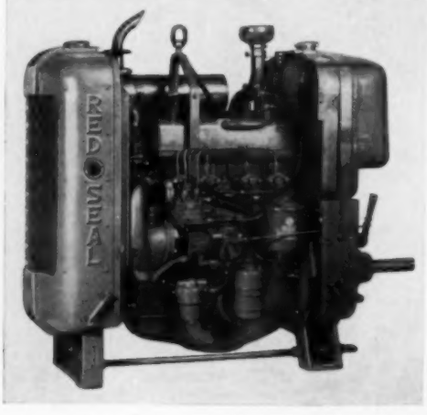
Sectional view of the VD8603



ABOVE—Model HD-260 4 cylinder Industrial Diesel Closed Power Unit, Develops 59.3 bare engine hp. at 2000 rpm.

BELOW—Corresponding Open Power Unit of the Model HD-260 4 cylinder Industrial Diesel.

Model GD-157, 4 cylinder Industrial Diesel Open Power Unit develops 39 bare engine hp. at 2000 rpm.



shell type, steel backed and lined with corrosion-proof metal.

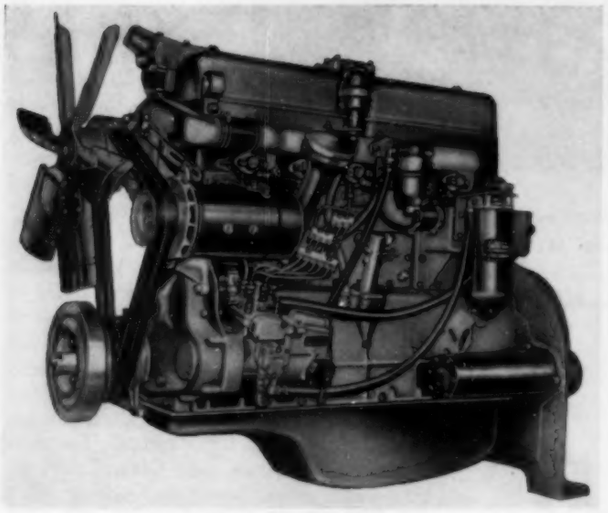
CONNECTING RODS are heat treated, drop-forged steel, with bronze bushings in the upper ends and replaceable shell at the lower end, like the main bearings.

INTAKE VALVES are of alloy steel while exhaust valves are of austenitic steel with alloy steel inserts in the cylinder head. Valve springs are cadmium plated for longer life. Valves are actuated from the camshaft by pushrods and tappet cam followers.

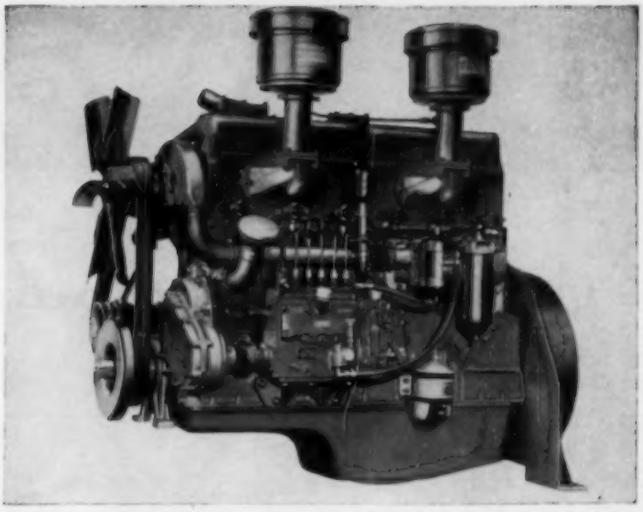
CAMSHAFTS on the GD-157, ED-201, ED-208, HD-243 and HD-260 are heat treated, semi-steel castings. On models TD-427, TD-6427, RD-572, RD-6572, SD-802, SD-6802, VD-603 and VD-8603, the camshaft is heat treated dropforged steel. Cams are integral with the shaft and ground to accurate contours. Camshaft gears are helical type.

FUEL INJECTION is either an American Bosch or Roosa-Master unit. Speed of engine is controlled by a governor integral with the injector unit. Fuel is supplied by transfer pump within the injector unit and two stages of filters are fitted.

LUBRICATION SYSTEM: The pressure pump is of gear type, mounted in the oil pan and protected by a large screen. The cylinder walls are supplied with oil at proper intervals, even at low engine speeds, by means of indexed spurt holes on the thrust side of the larger ends of the connecting rods. Oil filters are standard equipment on the TD, RD, SD and VD models. The oil pan is of pressed steel and is of larger capacity.



Model RD-572, Continental's Industrial Diesel (at left) develops 154 hp at 2000 rpm.



(At right) Model SD-802 Industrial Diesel develops 202 bare engine hp at 1800 rpm.

COOLING SYSTEM consists of a centrifugal pump with the impeller mounted on double ball bearings. The coolest water in the system is distributed first to the hottest spot in the engine through integral water distribution passages and external water distribution tubes. The cylinder heads have water passages fully adequate for proper cooling of valves and injectors. Cylinder walls are cooled by convection currents only, which keep the over-all temperature more uniform. Cooling water temperature is automatically regulated by a thermostat in conjuction with an adequate by-pass.

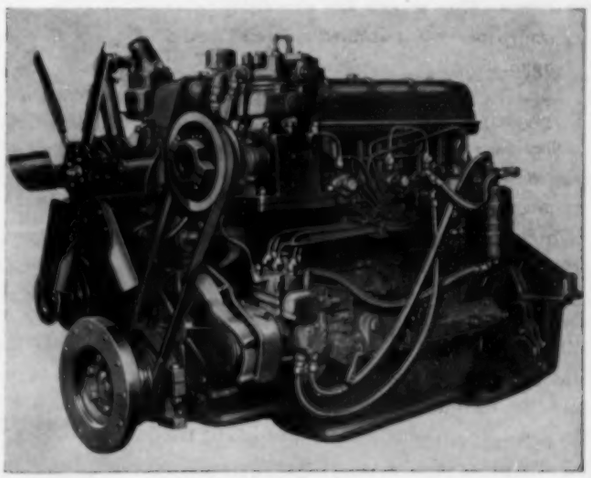
STARTING is by either a 12- or 24-volt electric motor, depending upon engine displacement and weather. An electric pre-heater and flame injector are available to assist in cold weather starting.

FLYWHEEL can be machined to take various SAE foot or drum type housings. Power take-off and reduction gears are available to suit applications.

OTHER ITEMS: an air cleaner is required and provision is made for it. The radiator fan can be mounted on the front end of the water pump shaft. Generators, sealed and ventilated, 12- or 24-volts, available with 10 to 50 amperes capacity and full voltage control regulators can be selected. Also available are switches to automatically stop the engine in case of high water temperature or oil pressure drop. Front and rear mountings are provided for by flange, pad, or trunnion type.

Continental Red Seal VD8603 cushioned power diesel transportation engine.

Model TD-6427, 6 cylinder Transportation Diesel develops 116 bare engine hp. at 2400 rpm.



CONTINENTAL DIESELS

Model	Cycle	H.P.	Cyl.	Bore	Stroke	R.P.M.	Inj'n Pump	Wt. lbs.	Height	Length	Width	Application	Starting
ZD-129*	4	34	4	3¼	3⅞	2000	Roosa	485				S.	Electric
GD-157	4	39.0	4	3⅜	4¾	2000	Roosa-Bosch	605	30¼	31⅛	15¾	S.A.M.	Electric
ED-201*	4	45.8	4	3⅝	4⅞	2000	Roosa-Bosch	655				S.	Electric
ED-208*	4	47.4	4	3 11/16	4⅞	2000	Roosa-Bosch					S.	Electric
HD-243	4	54.7	4	3¾	5½	2000	Roosa-Bosch	840	35	33¾	21¾	S.A.	Electric
HD-260*	4	59.3	4	3⅞	5½	2000	Roosa-Bosch	840	35	33¾	21¾	S.	Electric
HD-277*	4	63.2	4	4	5½	2200	Roosa-Bosch	850	35	33⅝	21⅝	S.	Electric
JD-382*	4	72.5	4	4½	6	1600	Roosa-Bosch	925				S.	Electric
TD-427	4	106.5	6	4 1/16	4⅞	2000	Roosa-Bosch	1160	35¾	47	24⅛	S.	Electric
RD-572	4	154	6	4¾	5⅜	2000	Roosa-Bosch	1845	42 5/32	51 11/16	29 7/16	S.	Electric
VD-603	4	175	8	4¾	4¼	2600	Roosa-Bosch	1655	46 21/32	43 13/32	34	S.	Electric
TD-6427	4	116	6	4 1/16	4⅞	2400	Roosa-Bosch	1270	35¾	47	24⅛	T.M.	Electric
RD-6572	4	172	6	4¾	5⅜	2400	Roosa-Bosch	1785	45 4/32	51 11/16	29 7/16	T.M.	Electric
SD-802	4	202	6	5 1/16	5½	1800	Roosa-Bosch	2160				S.	Electric
VD-8603	4	182	8	4¾	4¼	2800	Roosa-Bosch	1640	46 21/32	43 13/32	34	T.	Electric
SD-6802	4	225	6	5 1/16	5½	2200	Roosa-Bosch	2150				T.M.	Electric

S—Stationary; M—Marine; T—Transportation; A—Agriculture.

* Available for industrial applications only.

INTERNATIONAL HARVESTER

FOUR-CYCLE DIESEL ENGINES

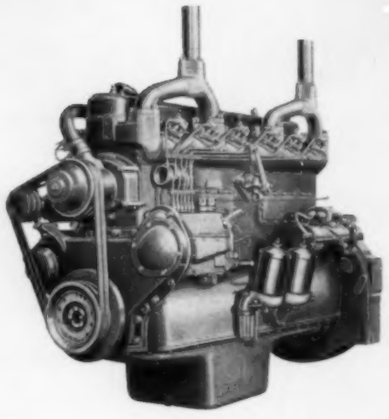
INTERNATIONAL four-cycle Diesels are built for a wide range of uses. This objective is achieved with six basic engines ranging from 57.5 to 203 horsepower and corresponding piston displacements of 264 to 1091 cubic inches. Three of the engines are 4-cylinder and the other three are 6-cylinder. They are all built (1) in stripped engine form, (2) with essential component groups to make self-sufficient sources of power, (3) with additional attachments which make the engines immediately adaptable to power applications, (4) in tractors suitable for mounting or drawing allied equipment. International Harvester Company uses these engines to power several wheel tractors and all of their crawler tractors. In addition, over 100 manufacturers use these engines to power their equipment. They provide low cost diesel power for many types of belt or direct-connected on-the-job application.

To properly meet these varied requirements, the engines are available in a range of speed ratings, with variable speed or close regulation governors, with standard SAE flywheel housings, with a choice of flywheels, with simple front engine supports, and with pads, bosses, and tapped holes for mounting special equipment and controls.

All these variations are purposely offered so that these engines can be applied in many different ways. But the fundamental design details and the distinguishing characteristics of International Diesel engines are similar for all the sizes and are illustrated and discussed here.

CRANKCASE of alloy iron is of rugged design and in one piece for the engine. The upper part acts as a full-length water jacket for the separate individual cylinder liners. The lower cross members are machined for the crankshaft main bearings. The cast iron oil pan is bolted to the bottom flanges of the crankcase. The cylinder heads are secured to the top of the block by long studs.

CYLINDER LINERS, wet and dry type are used, are replaceable and are cast of close grained, electric-furnace steel, and heat-treated. They have uniform cylinder wall thickness, and are honed and polished on the inside.



Left front view of the basic UD-1091 diesel engine.

CRANKSHAFTS are drop forged steel with induction-hardened bearing surfaces. Shafts are rifle drilled for pressure lubrication. Main and crankpin bearings are of precision, replaceable type.

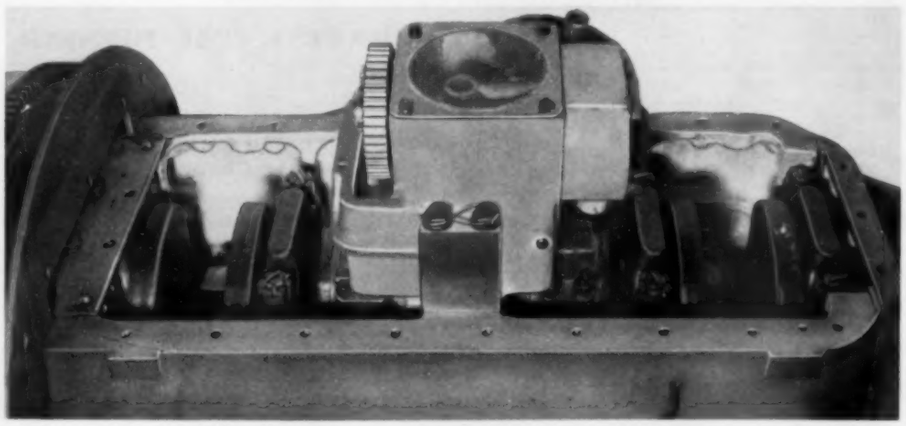
CONNECTING RODS are drop forged steel, rifle drilled for pressure lubrication to the piston pin. Upper ends have bronze bushings for the full floating piston pin.

PISTONS are of aluminum alloy with thick crowns for easy and rapid dissipation of heat to the water jacket. Piston pin is full floating type.

CYLINDER HEADS of alloy iron are in one piece for the four-cylinder engines and in two pieces for the six-cylinder engines. For each cylinder there is an inlet and exhaust valve, both of alloy steel, a precombustion chamber set at a 45° angle at the side, with its fuel injector, and a starting valve and spark plug. Inlet and exhaust valves are operated from the camshaft in the crankcase by pushrods and forged steel rockers. Rockers are carried by brackets attached to the top of the cylinder head. The valve mechanism is enclosed by an easily removed oil-tight cover on top the cylinder head. Valve-tappet and valve-stem guides are replaceable. Cylinder head is fully water jacketed to give uniform temperature.

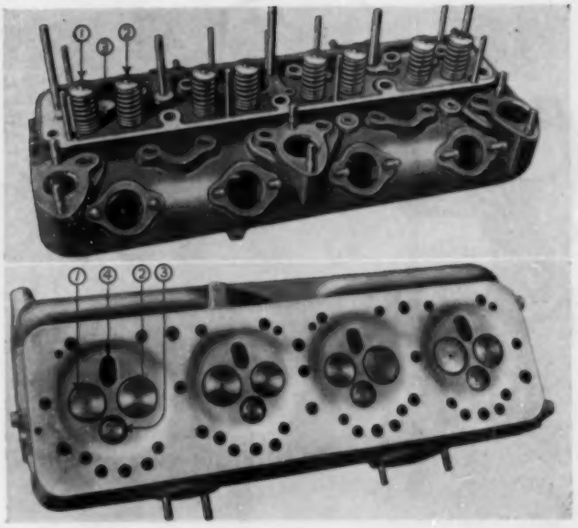
CAMSHAFT is a steel forging with cams integral. Wearing surfaces are induction hardened and carefully ground to correct contours and sizes. Camshaft, and injection pump on opposite side of engine, are driven by wide-faced, helical timing gears.

The Lanchester balancer located in the center of the crankcase provides extra-smooth operation and is used in the 4 cyl. UD14A and UD350 engines.



INLET AND EXHAUST MANIFOLDS on the four larger engines are located on opposite sides of the cylinder head to assure ample port areas in the head and to keep the incoming air cooler. Flow of exhaust gases from the engine is direct and unrestricted. The overall effect is to get thorough scavenging of the cylinder and a full charge of fresh air for the next combustion.

COMBUSTION CHAMBER is shown in section in the picture and its action is described. It is designed specifically to use commercial fuels available, and give clean combustion with controlled cylinder pressures. Compression ratios are 15 to 16.5 to 1. Water jacketing keeps these combustion chambers at the proper temperature for continuous maximum power output. A sealed heat insulating air gap maintains the right temperature in the upper part of each precombustion chamber for smooth idling. The good fuel economy attained is recorded in official Nebraska tests.



Two views of Model UD-14A cylinder head. (1) exhaust valve (2) intake valve (3) starting valve (4) opening to precombustion chamber.

FUEL INJECTION NOZZLES are of International design, of single-orifice type, and can be individually removed and replaced. Nozzles are of the closed type and the spring loaded valve opens in the direction of the fuel flow, eliminating any draining or waste of fuel. Injection pump action furnishes sharp injection with positive sharp cut-off at end of injection, without dribble.

FUEL INJECTION PUMPS are International design and manufacture, and feature "Minimum plungers for maximum performance." On four cylinder Diesels, a single helix-type plunger forces fuel to independent distributor valves assuring uniform injection to all cylinders in accordance with load and speed demands. A twin plunger pump incorporating the same principles is used in six cylinder engines, each plunger supplying three cylinders. With equal quantities of fuel delivered to each cylinder, equal power is obtained from all cylinders for inherent smooth operation of the engine at all speeds.

The essential working parts of both types of pumps and an outside view are shown in the illustrations. The complete unit is mounted on the side of the engine where it is accessible, and can be removed and replaced if necessary. Injection pump characteristics are such that as engine speed is pulled down by overload, a greater charge of fuel is delivered to each cylinder per power stroke, taking advantage of the excess charge of air present to increase lugging ability (engine torque). This increases power in tough spots.

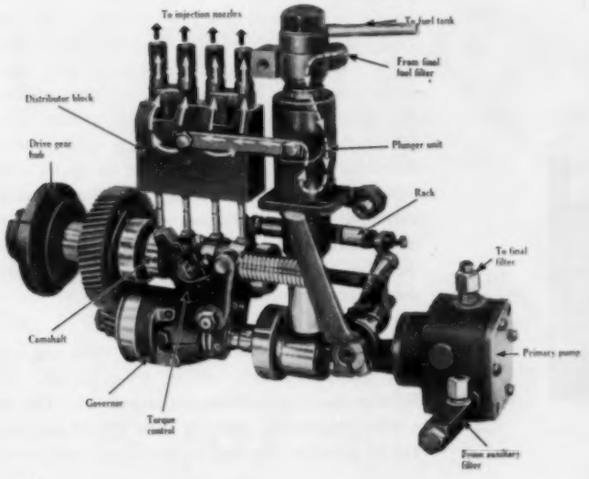
Filtered fuel is furnished to the plunger units by a gear-type primary pump driven from the rear end of the governor shaft. The helix-type plunger meters the fuel and develops the injection pressure. Variations in fuel delivery to suit load changes are acomplished by rotating the plunger in its barrel. Plunger unit has a reverse flow check valve that assures sharp-cut-off at end of injection and prevents dribbling at the nozzle.

Each plunger is actuated by a needle bearing eccentric. Fuel under high pressure is directed to the proper cylinder in accordance with the firing order of the engine through poppet type valves located in the distributor unit which are opened by cams prior to the start of injection. The camshaft rotates at one-half engine speed. On the twin plunger model, the governor shaft turns at 1½ times engine speed, and in the single plunger model, it turns at twice engine speed. The higher speed reduces the size of the governor weights for good governor sensitivity.

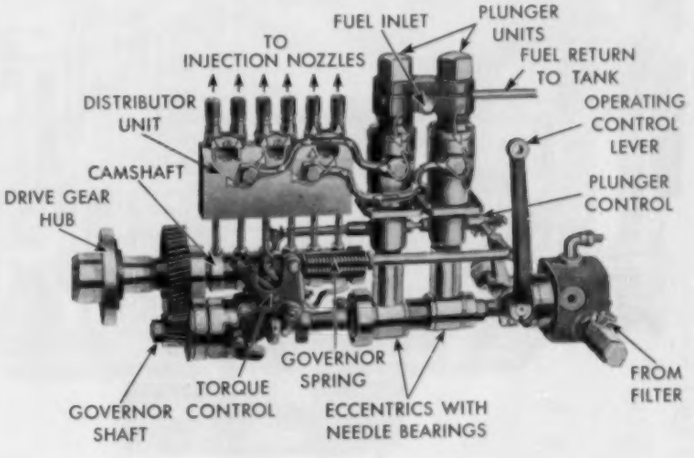
Screen and metal filters are located at strategic points in the fuel system, in addition to the normal filters provided, to catch any dirt introduced during servicing operations. Injection pump housing is completely sealed and vented only for breathing purposes.

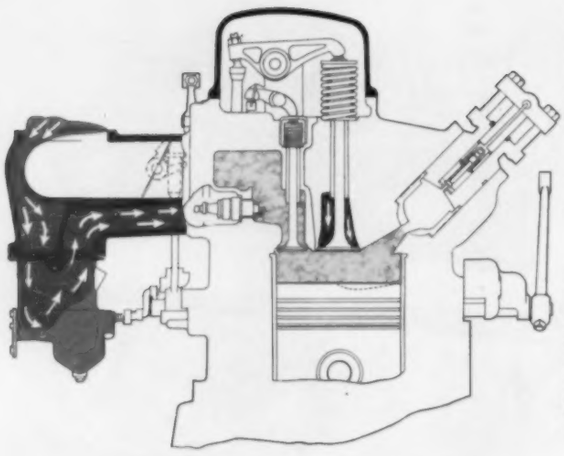
The built-in torque control is an essential element of the governing mechanism of the injection

Skeleton view of International single-plunger Diesel fuel injection pump.



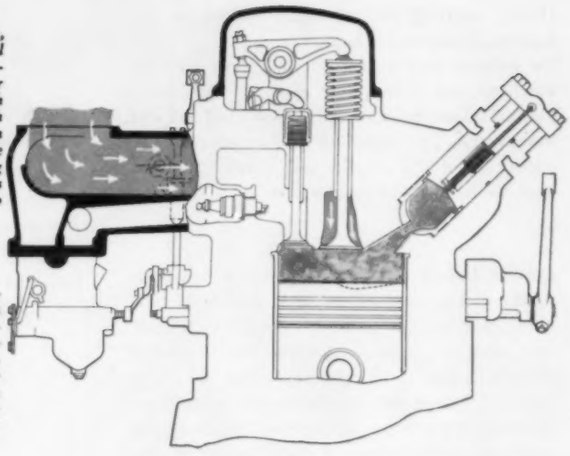
Skeleton view of International twin-plunger Diesel fuel injection pump.

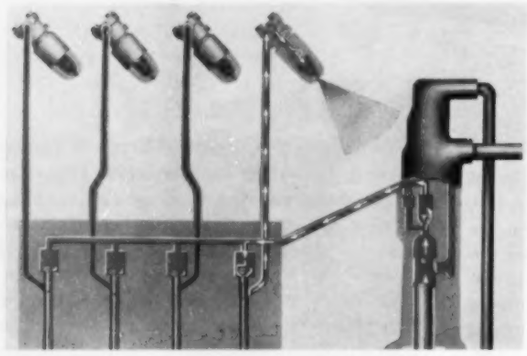




Left:
Diagram showing the positive, all-weather International Diesel starting system in operation. Incoming air is shunted by air intake manifold valve through carburetor where it mixes with gasoline to form the combustion charge. Gasoline starting valve is shown open, thus connecting the two combustion chambers and reducing compression ratio from 15.5:1 to 6½:1.

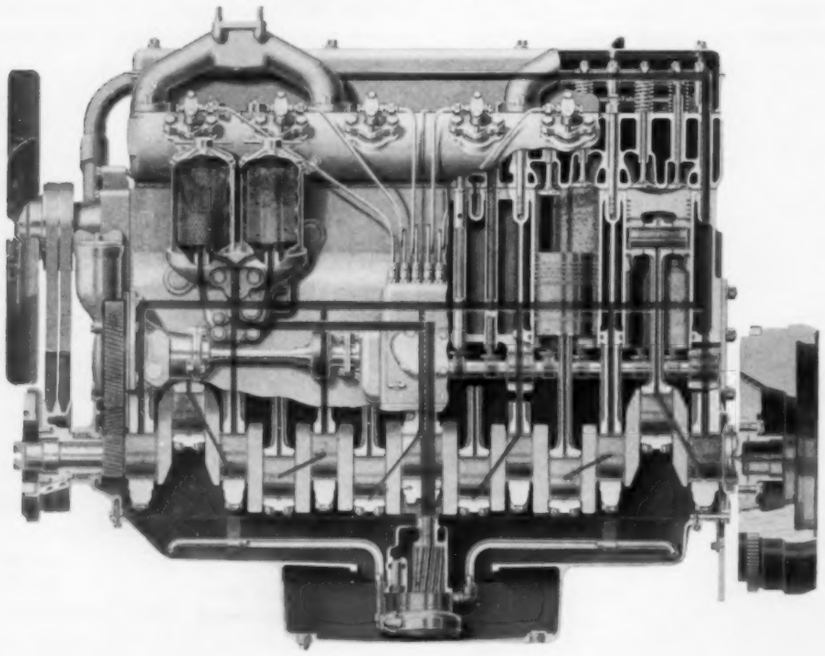
Right:
Diagram showing the International Diesel while operating on full Diesel cycle. Air flows directly from intake manifold to combustion chamber. The starting valve is closed isolating the gasoline starting combustion chamber and reestablishing the compression ratio of 15.5:1 for compression ignition.





The injection pump delivers an equal, metered quantity of fuel to each cylinder at the proper time. There is no loss from unequal fuel injection or waste at the nozzle. During injection the injection pump plunger forces the fuel charge past the spring-loaded fuel injection check valve, distributor valve and nozzle valve to each precombustion chamber along the path indicated by the arrows.

Diagram of full-pressure lubrication system for International six-cylinder, full-Diesel engines which is similar to all International Diesels. Oil is pumped from the sump to the filter base, and filter elements, then forced through rifle-drilled passages in the crankcase to the main and camshaft bearings. A pressure relief valve in the filter base maintains the proper pressure in the bearings. Oil from main bearings passes through drilled passages to the connecting-rod bearings and then to the piston pins and cylinder walls. From the camshaft, oil lubricates the valve mechanism under pressure and drains through the push rod holes to lubricate tappets and cams. The timing gear train is also lubricated from the camshaft. All I. H. industrial Diesel engines have full flow lube oil systems where all the oil is filtered before going to parts to be lubricated.



pump unit and its effect is shown in the performance curves of the engines. In the new model "B" pump the scavaging system is eliminated. The fuel flow can be traced by referring to the schematic drawing.

LUBRICATION is by pressure feed, with all passages rifle drilled. There are no internal oil pipes to come loose. The importance of clean oil is recognized by the provisions to keep it clean by first, effective sealing of the enclosures for the working parts; second, the floating-type screen at the lubricating oil pump inlet; third, the large capacity oil filters.

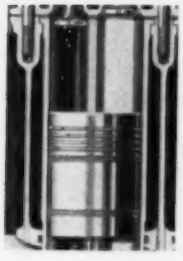
The air intake is provided with an oil bath type of air cleaner. The gear-type lubricating oil pump is in the sump and is driven by gearing from the camshaft. Hinged to the pump suction, the inlet screen floats near the surface of the oil in the sump and draws only the cleanest oil, leaving the sediment at the bottom. Oil filters are located accessibly at the side of the engine and have replaceable elements. Full flow filters are used on all engines.

The flow of the lube oil through the engine is shown in the sectional illustrations.

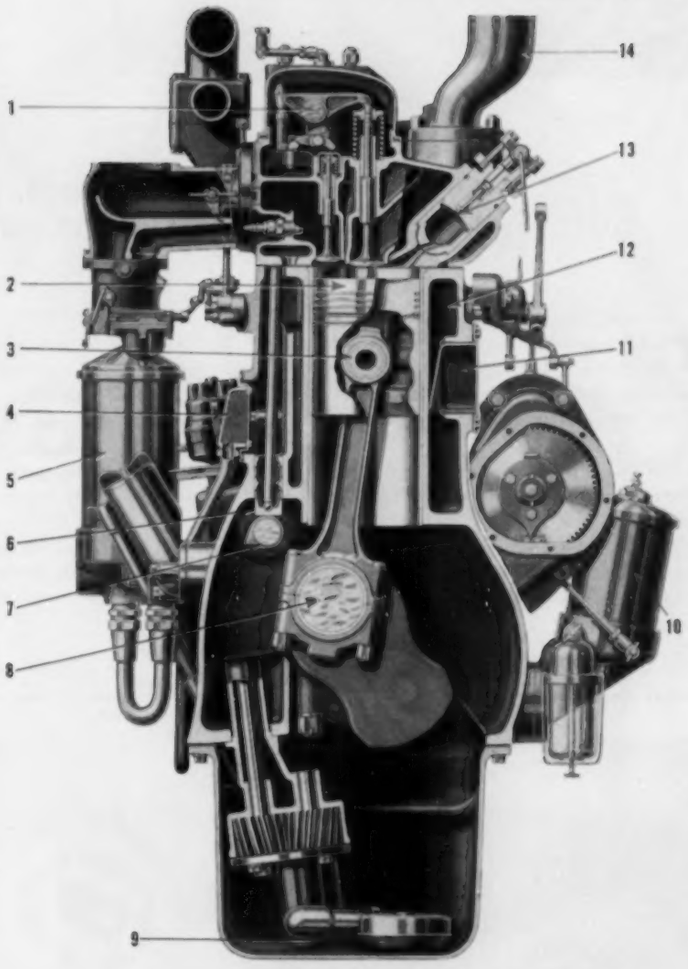
COOLING WATER is circulated through the engine jackets by the V-belt driven centrifugal-type water pump mounted at the forward end of the cylinder block near the top. The hub of the water pump shaft in front of the pulley carries the radiator fan when it is used. The pump shaft runs on ball bearings. A by-pass type thermostat controls circulation of the cooling water for maintenance of proper engine operating temperature. When the engine is cold, the water circulates only through the engine, assuring a uniform, quick warm-up. After the engine warms up, the thermostatically controlled valve opens and governs the flow through the radiator to maintain the proper temperature.

STARTING is a special feature of these engines, and considering the uses of these Diesels, all-weather starting is most important. The flip of a lever temporarily converts these Diesels to operate as gasoline engines, as explained previously.

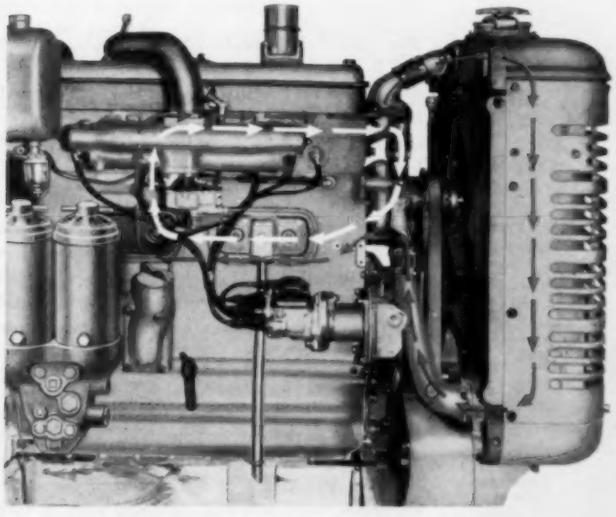
1. *Pressure-Lubricated Rocker Arm Shaft.*
2. *Aluminum Alloy Pistons.*
3. *Full-Floating Piston Pins—distribute wear for long life. Pressure-lubricated through drilled connecting rods.*
4. *Filter-Protected Crankcase Breather.*
5. *Replaceable Lubricating Oil Filter—full-flow lubrication with large capacity replaceable filter elements.*
6. *Hardened Valve Lifters—smooth-running and silent.*
7. *Pressure-Lubricated Camshaft—large bearing areas contribute to long life.*
8. *Precision Bearing Crankshaft—main and connecting rod bearings are precision type . . . journals are induction-hardened for thousands of hours of wear.*
9. *Oil Intake Screen—sets deep in oil for positive inflow of oil to pump at extreme angles of operation.*
10. *Auxiliary Oil Pump Intakes—take oil from ends of pan when engine is operating on inclines.*
11. *Efficient Replaceable Fuel Filters.*
12. *Cooling Water Baffle—directs water against cylinders.*
13. *Full-Length Water Jackets—provide excellent cylinder cooling.*
14. *Advanced Design Fuel Injection—precombustion chamber type with single-hole nozzle and 45° angle of injection.*
15. *Straight-Line Exhaust Scavenging—intake and exhaust manifolds located on opposite sides of engine. Incoming air is cool, and volumetric efficiency, "breathing ability" of the engine, is high.*



Full-length water jackets in the upper part of crankcase maintain proper cylinder temperatures and reduce oil consumption.



Side view of an I. H. engine, showing the path of coolant during engine warmup with red arrows, and after warmup with white arrows.



INTERNATIONAL DIESEL POWER UNITS

MODEL	Piston Disp. cu. in.	Bore & Stroke	No. of Cyl.	Max. Torque lbs.–ft. @ RPM	Engine Intermittent hp. @ RPM	Application
UD-264	263.9	4 x5¼	4	188 @ 1100	55 @ 1800	IT
UD-350	349.9	4½x5½	4	247 @ 1200	75 @ 1800	IT
UD-14A	460.7	4¾x6½	4	340 @ 1120	100 @ 1800	ITM
UD-525	524.9	4½x5½	6	380 @ 1150	115 @ 1800	IM
UD-18A	691.1	4¾x6½	6	462 @ 850	125 @ 1600	IT
UD-1091	1090.6	5¼x7	6	820 @ 1050	200 @ 1500	IT

(Application): I–Industrial T–Tractor M–Motor Grader

Engine Dimensions (inches)

Key	Description	UD-264	UD-350	UD-14A	UD-525	UD-18A	UD-1091
A	Overall Length	38½	41½	47 1/16	56¾	60¼	70 1/16
B	Overall Width	23	24	27¼	30¼	31⅝	32 11/16
C	Centerline To Top	26 5/16	29½	31⅜	31 11/16	34⅜	37⅜
D	Centerline To Base	12⅝	13	13⅛	12⅞	14½	17¼

Power Units Dimensions (inches)

Key	Description	UD-264	UD-350	UD-14A	UD-525	UD-18A	UD-1091
A	Overall Length	62 5/16	65½	78	88¼	95⅞	107 5/16
B	Overall Width	25⅜	27 5/16	33⅛	35⅞	35⅞	44
C	(Without Throttle) Overall Height	47	53 7/16	56½	57¼	59¾	72
D	P.T.O. Height	13⅜	13⅝	15¼	14¼	15¼	17½

KAHLENBERG

THE MODEL E 2-CYCLE TURBOCHARGED DIESEL

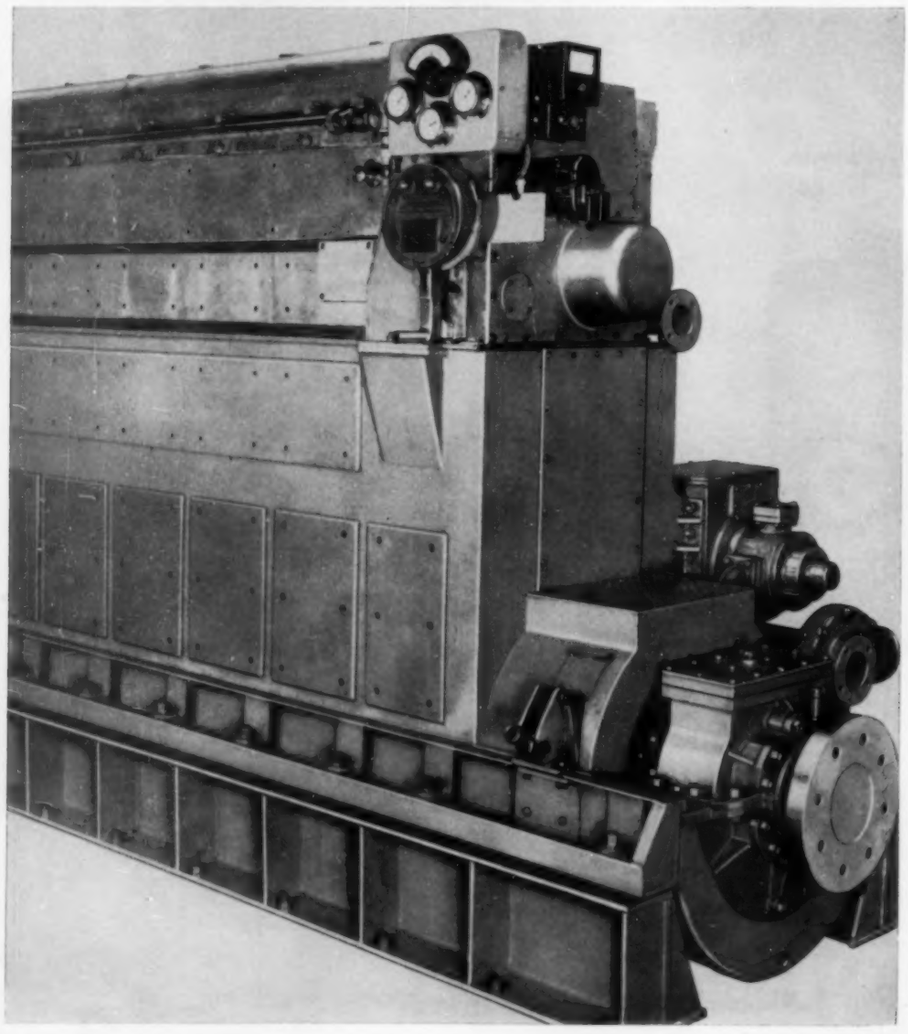
THE Kahlenberg Model E Diesel is a vertical, heavy duty, direct injection, two cycle engine employing uniflow scavenging and pulse system exhaust turbocharging.

This engine is intended for general service in a variety of fields, both stationary and marine. For marine work, it is suitable for use as a direct drive unit and is direct reversible. Reduction gears can be adapted for extremely low propeller speeds as well as multiple geared drives.

Tests at 300 to 400 RPM and 100 psi show a very flat fuel curve with excellent operating characteristics and good combustion. Average specific fuel consumption of .380 per BHP is obtained driving all auxiliaries, including sea water and jacket water pumps. Piston speed of only 1066 feet per minute at 400 RPM is indicative of long life.

Turbocharging is on the pulse system, using dry type manifolds. Each manifold is carefully streamlined and volume controlled to provide maximum possible pulse energy to turbine nozzles. Manifolds are lagged to retain the exhaust heat energy, and can be removed without disturbing the insulation.

View of the Kahlenberg Model E full diesel. It operates in either direction of rotation throughout its entire range. Note the clean design of the engine.



Scavenging air from the turbocharger goes through a large area inter-cooler before entering the engine air box. This reduces charge temperature and lowers the thermal loading of cylinders, thus increasing charge density to permit greater power output.

Welded frame construction is used, resulting in greatly reduced weight for a low RPM heavy duty Engine. Crankshaft and bearings are bedded in the engine frame, and all bearings are accessible through crankcase doors without removing the Engine from its foundations. Crankcase doors are of aluminum with special latches for easy removal. The steel frame is U type, one-piece design with through-bolt stress members. The base runs the full length of the Engine to coupling, and for marine service a separate adjustable type thrust bearing is mounted inside the engine base between flywheel and coupling.

The crankshaft is machined from a solid forging and is drilled for lubrication. Main bearings consist of lined steel shells and backs rigidly supported in the base. Crankpin bearings are two-piece type consisting of removable and interchangeable lined bronze-backed shells.

Removable individual cast iron cylinder jackets are used with wet type removable liners of a special analysis iron. Liners are machined overall for uniform section, accuracy of porting, and proper fit. Water jacket connections are made with flanged jumpers.

Pistons, which are oil-cooled, are of special iron, thoroughly annealed and ground. The pistons with rods are removable through the crankcase doors, thus making it unnecessary to remove cylinder heads, valve gear and associated parts to take out pistons, although this can be done if desired. The piston pin is semi-floating type, clamped in the eye of the connecting rod, floating in two bronze pin bushings. Connecting rods and piston pins are specially drilled for full flow oil cooling of the piston. The connecting rods are fully machined steel forgings.

A one-piece camshaft removable as a unit without disturbing the camshaft drive is driven from the crankshaft by a multiple roller chain, as are

the scavenging and pressure lube oil pumps, fuel transfer pump and centrifugal jacket and sea water pumps when used. Each individual cylinder head has two exhaust valves in water-cooled cages, a fuel injection nozzle and a caged poppet type starting air inlet valve. Valve operating gear is entirely pressure lubricated. A special valve shield is provided, making it impossible for an exhaust valve to drop into the cylinder under any circumstances. Valve gear covers are made of cast aluminum for lightness and ease of handling.

Fuel pumps are individual type and are mounted in a gallery immediately above the cam box and adjacent to the cylinder heads, thus utilizing extremely short injection tubes of equal length. Racks are interlocked to a common governor control rod. Either mechanical or hydraulic governor is used, depending upon service application of the engine.

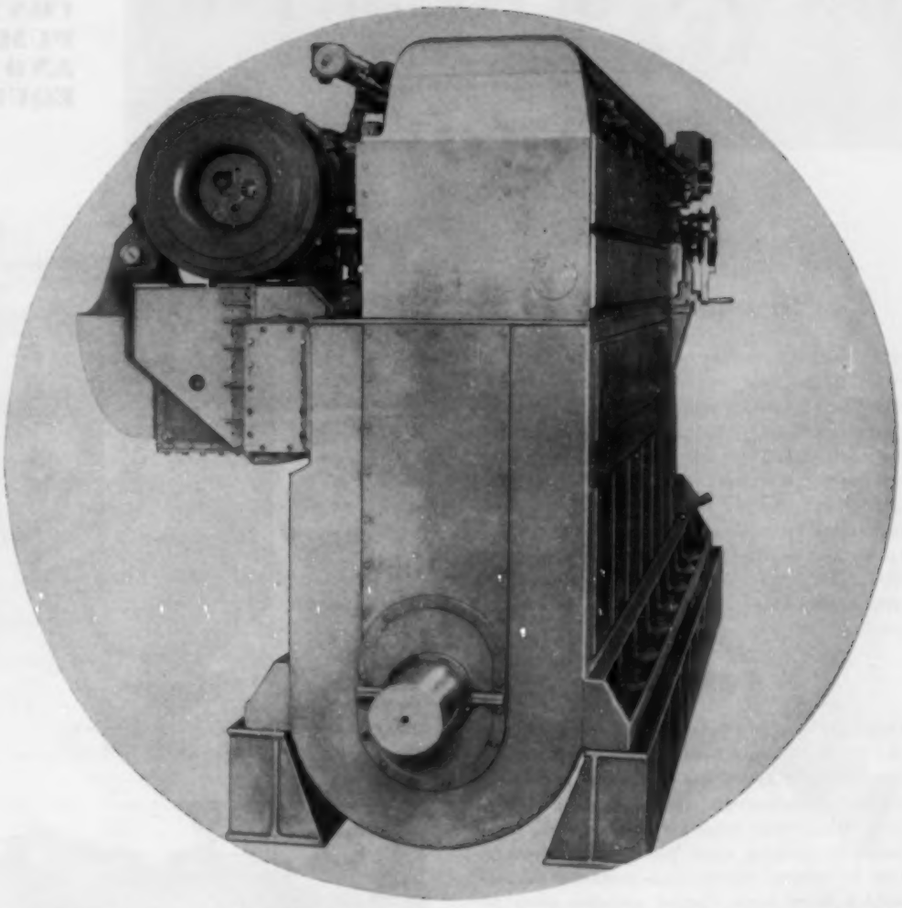
A shell and tube type lubricating oil cooler of large capacity controls oil temperature, while engine jacket water cooling arrangements are flexible with water supplied through engine driven or motor driven pumps, as required for the individual installation.

A thermostatic by-pass valve is used to maintain constant engine jacket water temperature.

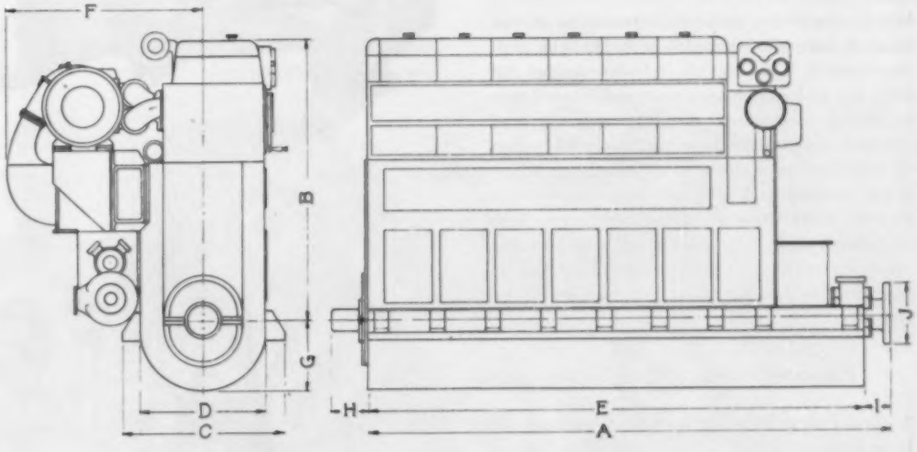
Control of the Engine is centralized in a single lever near the aft end. For marine use, a movable camshaft is employed with a full set of cams for each cylinder, both for ahead and astern operation. The camshaft is shifted by a built-in air cylinder interlocked with the engine control lever. Starting air at 250 psi is automatically shut off as soon as the Engine begins operating. The reversing operation is entirely positive and exceptionally fast. The position of the camshaft is shown by special mechanical indicator on control housing. Complete control of the Engine, including reversing, can be from either usual engine station or from remote positions such as engine room platform or pilot house.

Simplicity of maintenance is one of the keynotes of design of the Kahlenberg Model E. All access doors and covers are of aluminum for lightweight and easy handling. Bearings and pistons are removable from crankcase doors. Pumps, valves and even cylinders can be removed as individual unit assemblies.

The Model E Kahlenberg is offered in multiple cylinder units of four, five, six, seven and eight cylinders with normal rating of 95 psi bmep and speed range up to 400 RPM. Dimensions, weights, and power output data are tabulated in Table I.



The Napier turbocharger and the intercooler can be seen to the left in this view of the Kahlenberg engine. The Weston tachometer is on the instrument board at the right end.



Model	BHP at 95 psi bmep Rating			Weight, lbs.
	300 rpm	350 rpm	400 rpm	
E4	400	465	535	22,000
E5	500	585	665	26,000
E6	600	700	800	30,000
E7	700	814	930	34,000
E8	800	930	1065	38,000

Model	A	B	C	D	E	F	G	H	I	J
E4	9'-7"	6'-6½"	3'-10½"	2'-10½"	9'-0"	4'-4⅝"	19¼"	11 3/16"	7"	17¼"
E5	10'-10½"	6'-6½"	3'-10½"	2'-10½"	10'-3½"	4'-4⅝"	19¼"	11 3/16"	7"	17¼"
E6	12'-2"	6'-6½"	3'-10½"	2'-10½"	11'-7"	4'-4⅝"	19¼"	11 3/16"	7"	17¼"
E7	13'-5½"	6'-6½"	3'-10½"	2'-10½"	12'-10½"	4'-4⅝"	19¼"	11 3/16"	7"	17¼"
E8	14'-9"	6'-6½"	3'-10½"	2'-10½"	14'-2"	4'-4⅝"	19¼"	11 3/16"	7"	17¼"

MINNEAPOLIS-MOLINE

INDUSTRIAL DIVISION

STATIONARY OR PORTABLE— CONTINUOUS DUTY FOR PUMPS, GENERATORS AND CONSTRUCTION EQUIPMENT

D605-6A

MM model designations provide the basis for determining fuel type, displacement, and number of cylinders. MM builds heavy-duty high production engines in 3⅝, 4¼, 4⅝, and 5⅛ inch bore sizes and offers diesels in the two popular intermediate sizes. MM's large diesel has 605 cu. in. displacement, 6 cyl. and 4⅝ inch bore. MM controlled combustion provides high torque at moderate r.p.m. for a continuous heavy load operation on all applications. Special long run and low maintenance advantages produce lowest cost horsepower per hour.

D425-6A

Originally designed as an industrial engine this 425 cu. in., 4¼ inch bore six cylinder diesel now provides initial cost saving due to high production because of increasingly wide application that include tractor and irrigation pump power. Ideal range of operating r.p.m. provide rapid acceleration for shovels, ditcher, and hoists that impose sudden heavy loads. Careful attention given reserve capacity operating requirements is borne out by dual air cleaners and oil filters.

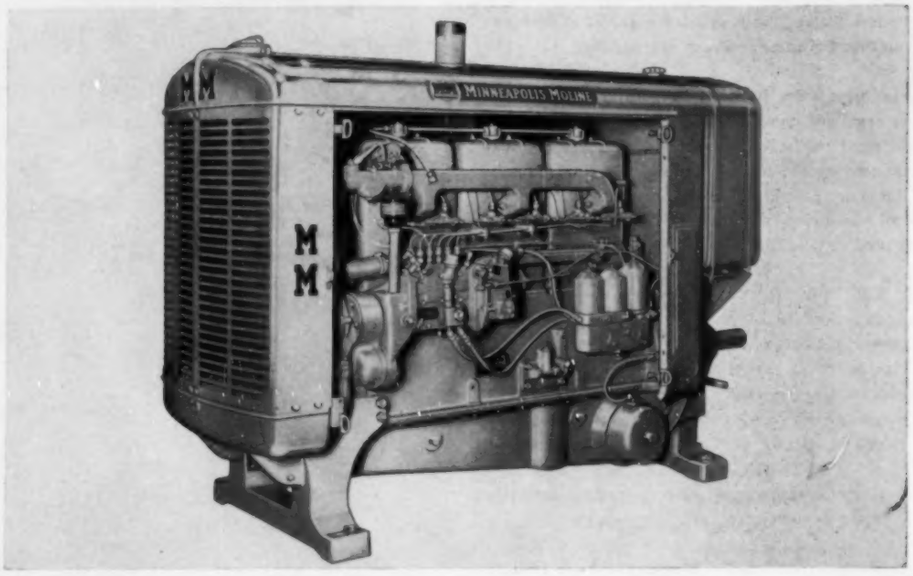
D283-4A

MM also builds 4¼ inch bore industrial work type diesel in four cylinder models with 283 cubic inch displacement. Like the six cylinder designs the D283 has 15:1 compression ratio and Lanova type controlled combustion. All MM diesels are of standard design to employ the best combination of dependability features either as regular or optional equipment. A standard design exception is that the D283 when furnished with regular base pan offers a single large capacity enclosed filter and Float-o-screen intake. The optional Thermo-Clad base pan has dual large capacity, enclosed shunt-type filters.

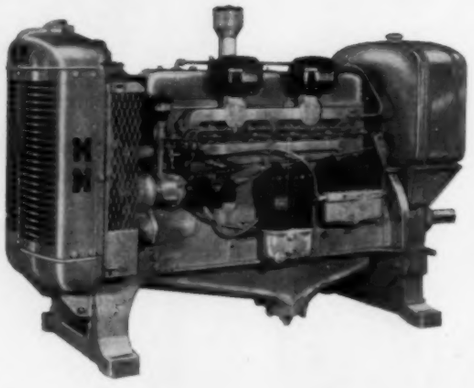
Patented 3-Stage Fuel Filter

A special large capacity fuel filter package has been designed by MM to assure utmost in low-cost trouble-free operation. Primary element is a fine mesh and the secondary and final filters are micronic paper—all are easily accessible.

GRAVITY FEEDING—To give effective filtering MM uses gravity feed through the primary and secondary filters to prevent forcing foreign material through or into the final filter element. Pressure feed through the final filter is supplied by a gear-type transfer pump included in the injection pump.

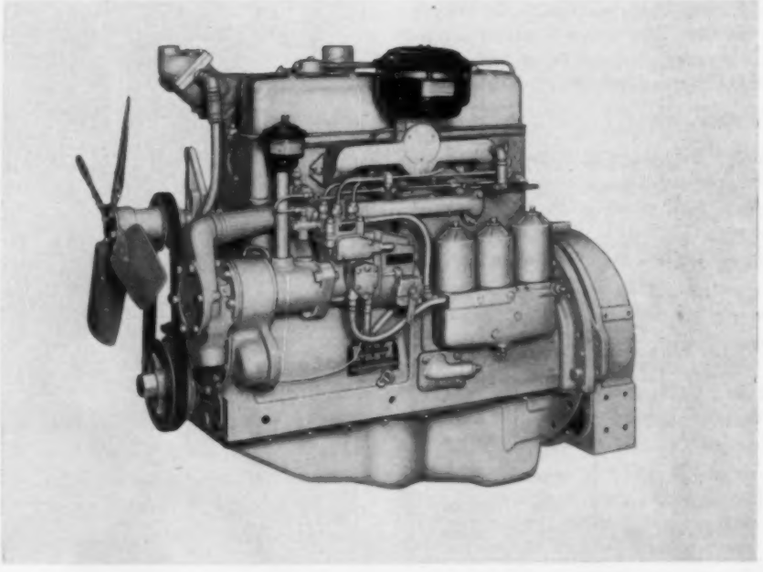


MM D605-6A enclosed unit with side covers removed to show fuel filter and injection system.



MM D425-6A open type unit with radiator, fan, and fuel tank—shows standard dual air cleaners and fuel filters.

MM model D283-4 available as fan to flywheel engine.



CRANKCASE VENTILATION—To provide the advantages of cleaner engine operation, manifold crankcase ventilation is furnished as regular equipment. Crankcase vapor and fumes are drawn out of the engine through the valve covers by lines connected to the intake manifold to reduce oil sludging, give more effective lubrication, and reduce frequency of oil changes.

CYLINDER HEADS—All MM cylinder heads are cast in pairs so that they can be removed easily and conveniently by one man. Valves are heavy stemmed and valve guides are extra long to assist cooling and fitted to control oil loss. Valve guides are replaceable and the exhaust valve seats are stellite inserts.

Exploded view of cylinder head and cylinder block shows MM removable design.

REMOVABLE CYLINDER BLOCKS—A major point of design difference in MM engines is that cylinder blocks are cast in pairs separate from the crankcase. They are cast of high grade alloy that does an excellent lubrication job and provides excellent low wear characteristics. In addition, the cylinders can be replaced at nominal cost, and on an emergency job, requiring only partial replacement, saves substantial cost.

CRANKCASE—High among the strong points in MM engine design is a rigid crankcase. In this respect they are made extra deep—nearly 4 inches below the center line of the crankshaft. Another feature of MM rigid design is the extra width and thickness of the flywheel housing flange.

MM exclusive Thermo-clad crankcase base pan is completely water jacketed and has enclosed oil filters . . . combination sight gauge and automatic level control.

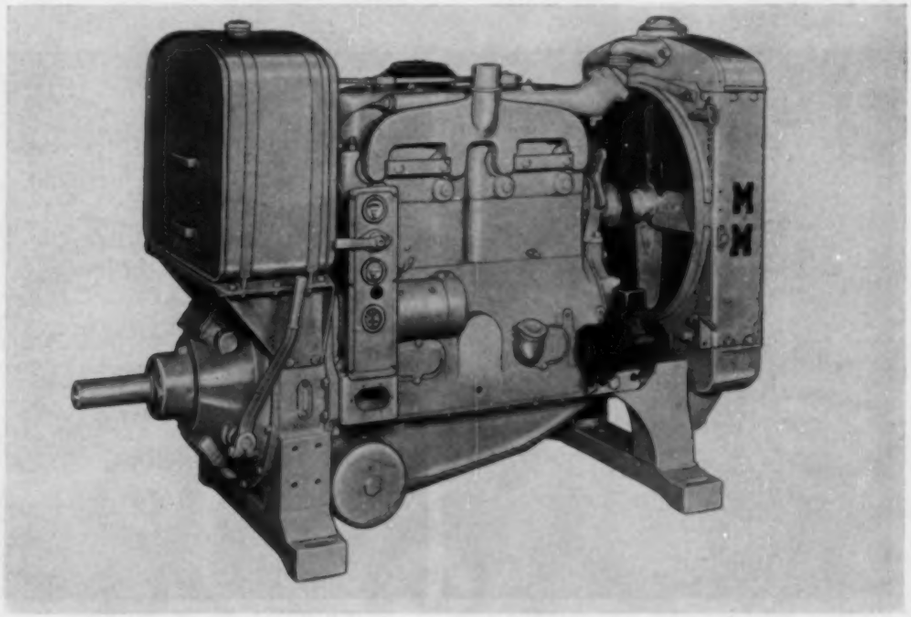
WATER BLANKETED BASE PAN—The above cross-section shows how MM uses engine water and water jackets to blanket the base pan and provide uniform operating temperature despite extreme or changing operating conditions.

Thermo-clad base pans are regular D605-6A equipment but are optional on the D425-6A and D283-4A. Important features of this MM exclusive design are, enclosed oil filters for effective filtering—reduction of condensation from blow by and consequent oil sludging—heat exchanger function that prevents distortion—heavy rear flange bolts to SAE housing and provides 360° effective rear main bearing support—combination sight oil gauge and oil level controller.

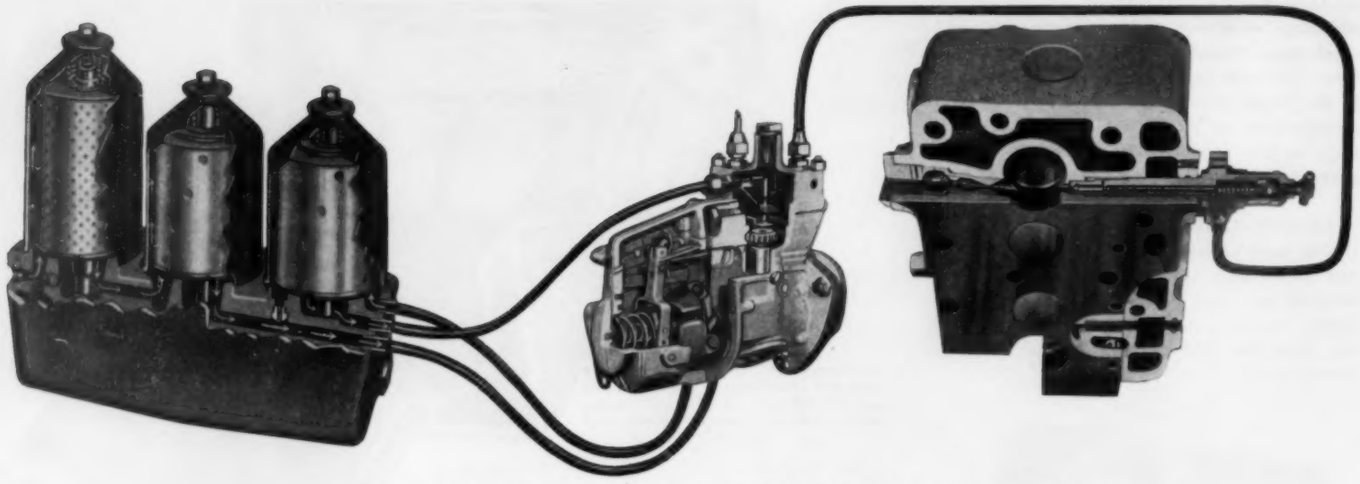
ENCLOSED OIL FILTERS—Two large capacity shunt type filters are located in the bottom of the Thermo-clad pan so that oil temperature never falls below the 170° considered necessary for effective filtering. Filter elements may be changed without draining the pan.

FULL FLOW OIL FILTERS—Dual full flow oil filters of large capacity are furnished as regular equipment on the D425-6A and are equipped with the MM safety by-pass feature.

PACKAGED WATER PUMP—To obtain greater dependability, efficiency, and service convenience, all MM diesels are equipped with a standard package water pump. The pump is gear driven and has a stainless steel shaft with a self-adjusting spring-loaded carbon seal. The pump is of ample capacity to serve both 4 and 6 cylinder units by variation of pump speed.



MM D283-4A open unit from energy cell side shows standard instrument and control equipment.



Cutaway section view of MM fuel injection system for 4¼ inch bore sizes show filter by-pass, enclosed governor, pintle-type nozzles and coolant directors.

SAFETY BY-PASS—Complete protection of the injection pump is provided by the MM safety by-pass located ahead of the final fuel filter. This eliminates the possibility of rupturing the final filter and allowing foreign material to damage injection plunger head.

American Bosch Injection Systems

PSB—Both MM D238-4A and D-425-6A 4¼ inch bore units are equipped with the recently introduced Bosch PSB. This is the single plunger type that handles moderate fuel requirements with great economy of initial cost, operation, and service. Outstanding considerations for use of the PSB are its enclosed governor and control rod, pressure lubrication and reduced number of wearing parts.

APE—To accommodate increased power and to maintain high torque feature the Bosch APE multiple plunger pump was chosen for the D605-6A 4⅝ x 6 inch unit.

The APE unit is flange-mounted and gear driven from the accessory shaft case that provides a convenient and easily accessible location. APE injection pumps have the highly desirable enclosed governor and control rod similar to the PSB type.

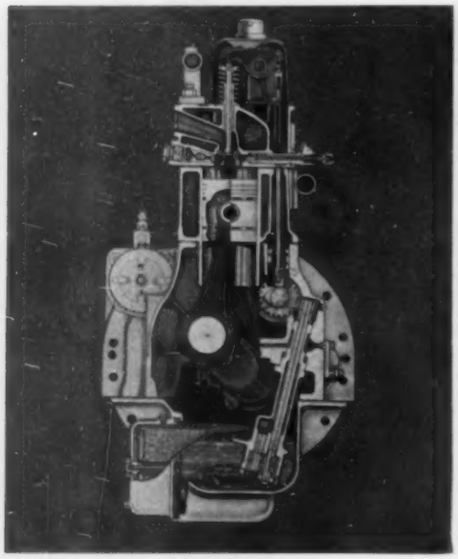
TORQUE CONTROL—Improved fuel economy and instant smoke-free power are a result of special torque plates MM has designed for individual engine requirements. This control governs the maximum injection of fuel without waste while delivering full torque throughout the operating speed range.

ENERGY CELL COMBUSTION—Single lobe Lanova combustion chambers give MM diesels high performance as well as greatly reduced maintenance by controlling and prolonging the pressure rise. The energy cell and its location result in a rotary turbulence that produces uniform combustion with less detonation. This serves to develop lower peak pressure that greatly extends overhaul interval. By prolonging the pressure rise MM energy cells develop high average pressure throughout the piston stroke to produce high torque at moderate speed.

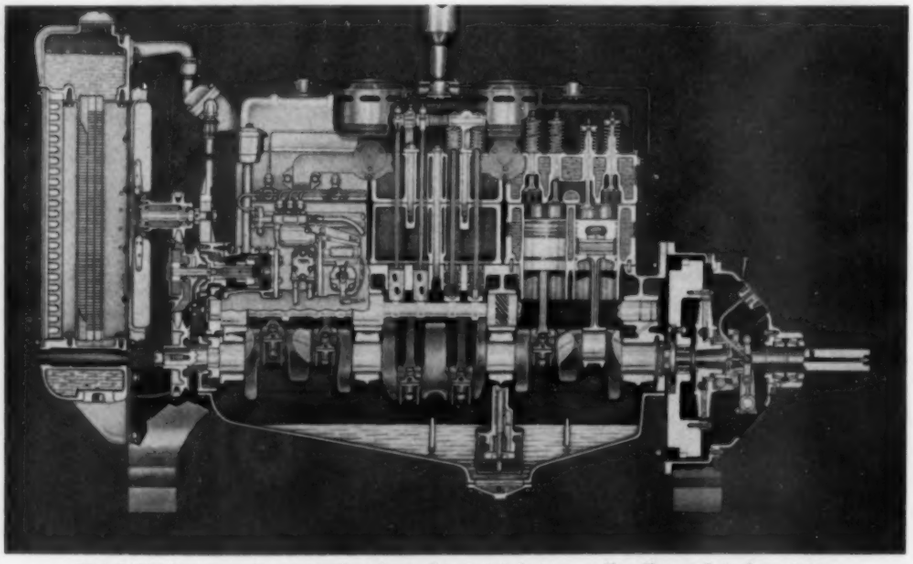
COOLANT DIRECTORS—To aid even burning MM employs two coolant directors or hydrants for each combustion chamber to maintain uniform temperature in the critically hot area. This retards detonation and loss of power under heavy load and high temperature conditions.

PINTLE TYPE INJECTOR NOZZLES—Increased dependability and prevention of fouling during periods of intermittent light loads are obtained by self-cleaning nozzles.

MM pintle type nozzles clean the fuel entry orifice constantly, atomize the fuel spray for better mixing, and are installed with O-ring seals for easy service and efficient leak-proof operation.



MM D283-4 engine cross-section shows standard crankcase base pan with enclosed oil filter.



MM D425-6A open unit cross-section shows thermostat by-pass cooling line and package type water pump.

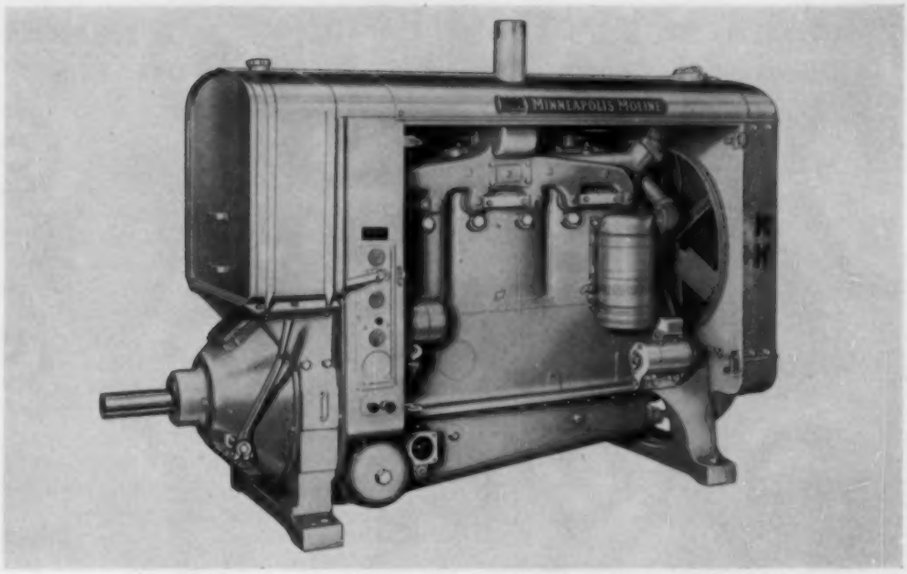
PISTONS—MM diesel pistons are the heavy-duty trunk type made of aluminum alloy. Piston ring make-up is: three compression (top ring chrome plated) and single oil control rings above and below the piston pin which is the full floating type.

CONNECTING RODS—All MM diesel connecting rods are drop-forged steel I-sections and are heat-treated. Bearings are copper-lead and have large area to obtain lighter loading . . . minimum down time.

CRANKSHAFTS—Particular attention is given to the layout of MM crankshafts to reduce stretch out length and maintain large main and connecting rod bearing area.

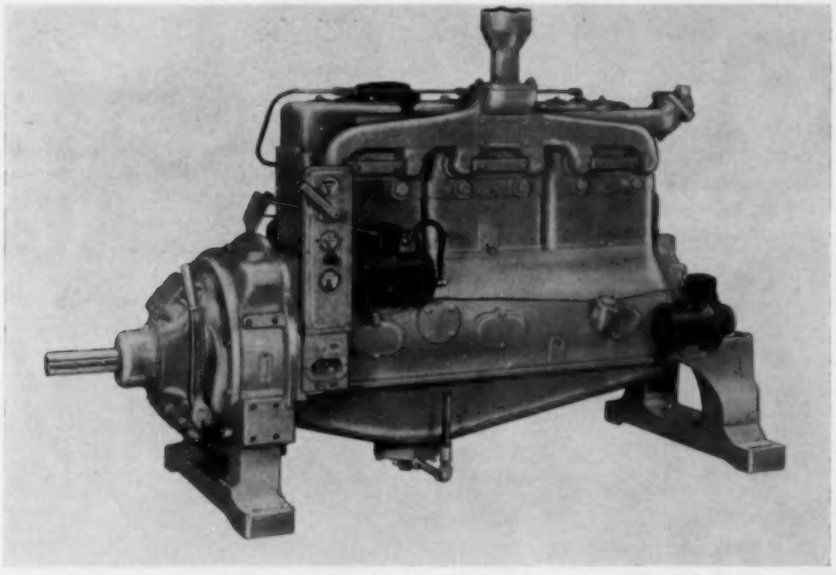
By the use of extra heavy cheeks and throws the D283-4A requires only one intermediate main bearing while the D425-6A and D605-6A require but two intermediate mains.

To further decrease bearing loads D425-6A and D605-6A crankshafts are counterbalanced. All MM diesel crankshafts are heat-treated and have precision type copper-lead bearings.



MM D605-6A enclosed unit. Thermo-clad base pan is regular equipment on this model.

MM D425-6A base unit (below) with power take-off. Starting motor and generator are 12-volt.



LUBRICATION—Full pressure oiling is supplied by a gear type pump submerged in the base pan. The pump is gear driven by a proferall metal camshaft and oil is directed by drilled leads to rod, main, and camshaft bearings; timing gears; valve mechanism; injection pump.

CONTROLS—Throttle control is located on the instrument panel. Both instrument panel and clutch lever can be located on either side of the unit. Special controls are available for hoist operation and provision is made for starting battery receptacle and starter button.

THERMOSTATIC BY-PASS COOLING—MM diesels are equipped with heavy duty thermostat located in the water outlet manifold to give quick warmup and maintain uniform engine temperature. To minimize thermostat surge, D283-4A and D425-6A standard base pan units have a by-pass line that connects the thermostat valve and the water pump. On Thermo-clad base pan models the by-pass line is coupled directly to the base pan jacket and then to the water pump.

INSTRUMENTS—Standard instruments include oil pressure gauge, temperature gauge, and provision for ammeter. Provision for alternate mounting of panel consists of a knockout plate in rear enclosure support.

UNIT TYPES—Engine or bare units are available without radiator and fan or power take-off in order to eliminate equipment not required for installations using cooling coils and direct drive. This also applies to replacement jobs where standard equipment from the replaced unit will fit.

OPEN UNITS—MM open type units eliminate enclosures required for some installations. Radiator, fan, fuel tanks and clutch type SAE power take-off provide complete portability and flexibility of operation.

ENCLOSED UNITS—For exposed all-weather installations MM units can be equipped with full enclosures consisting of hood, removable side covers and rear support when fuel tank is not required. The hood is hinged and side covers are hinged and removable. Latches permit folding top half of side cover down or bottom half up for increased ventilation. Enclosures and grille are steel plate with punched ventilating slots. Radiator consists of zinc-coated core and separately cast top tank, bottom tank, and side sections.

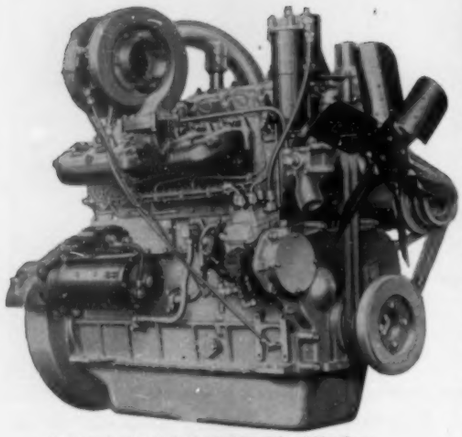
ACCESSORIES—Optional equipment available as factory installations include 12-volt starting motor, 12-volt generator, fan guard, pusher-type fan, radiator pressure cap, manifold heater or pressure primer to aid cold weather starting, hour meter, oil pressure and water temperature safety cutouts on fuel supply, electric starting receptacle, and drive pulleys.

Model	Cycle	HP*	Cylinders	Bore	Stroke	RPM	Fuel Sys.	Weight	Height	Length	Width	Application	Starting
D283-4A	4	55	4	4¼	5	1500	Bosch PSB	2100	46	54 69	25	General	Electric
D425-6A	4	83	6	4¼	5	1500	Bosch PSB	2750	48	68 87	25	General	Electric
D605-6A	4	107	6	4⅜	6	1500	Bosch APE	3500	52	68 87	29	General	Electric

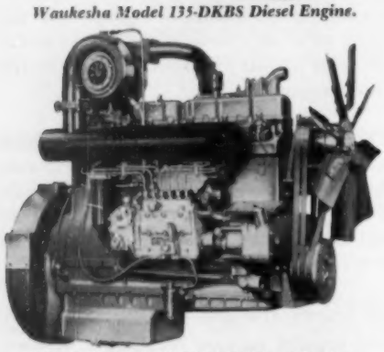
* Without fan.

WAUKESHA

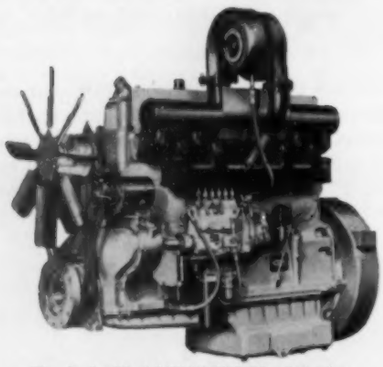
WAUKESHA DIESELS



Waukesha Model 135-DKBS Diesel Engine.



Waukesha Model 148-DKBS Diesel Engine.



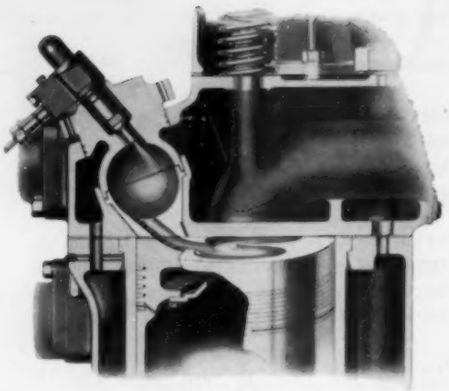
Waukesha Model WAKDBS Diesel Engine.

Waukesha Model LRDBS Diesel Engine.

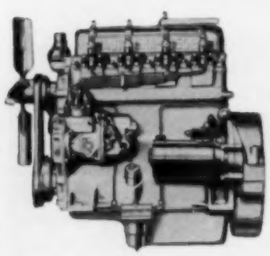
WAUKESHA'S recently introduced 5788 cubic-inch twelve-cylinder Diesel, the V-12 model VLRDB, in normal and turbo-supercharged versions, has increased its Diesel line to ten basic models ranging from 13 to over 1100 horsepower. All of them except the 144 cubic-inch four-cylinder 180DLC, and the V-12, are six-cylinder engines. All are of the four cycle type, all are built variously assembled and equipped with accessories to suit all of the different service and installation conditions where these engines work. Naturally the engine rating is varied to suit also. All engines are similar in general design and are built for heavy duty service.

TURBOCHARGING—The Waukesha Motor Company has extended the advantages of turbocharging to relatively small engines. It has been among the first to make use of the fairly recent availability of commercially produced turbochargers of small size, and is certainly the first of the engine builders to offer a turbocharged engine having only 426 cu. in. displacement. Turbochargers have been applied to six basic diesel engine sizes, four of which are shown at left. Three of the six engines are for transportation or industrial service and the three largest as complete power units for industrial service. The WAKDBS is supplied either as a bare engine or complete unit. The availability of turbocharging in this light-weight, high-speed engine field opens many new doors in the Diesel engineering field and could well have lasting and far reaching effects. Particularly important is their application to the transport industry.

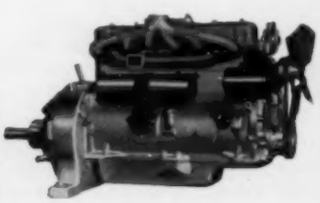
WAUKESHA COMBUSTION CHAMBER is distinctive. It consists of a two-piece insert, installed from the outside of the engine, with a spherical shaped interior connected to the main cylinder space by a specially shaped throat. The lower section with the tangential throat outlet is a Stellite precision casting, air-insulated from the cylinder head to prevent heat dissipation. The heat-resistant alloy upper section, carrying the injection nozzles, is surrounded by circulating coolant, to relieve the nozzle of excessive temperatures. Heat retained by the lower section augments compression heat and promotes prompt ignition. As load increases, the amount of stored heat also increases so there is no appreciable difference in ignition delay at any load or speed. Clean burning is a characteristic of this combustion chamber. By its spherical shape and the two swirl cups in the piston crown, the turbulence rate



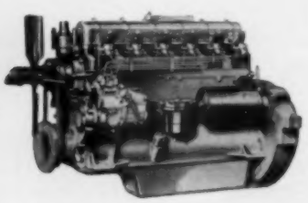
Cutaway view of upper cylinder block and head showing injector, two-piece controlled turbulence type combustion chamber, and swirl cups in top of piston.



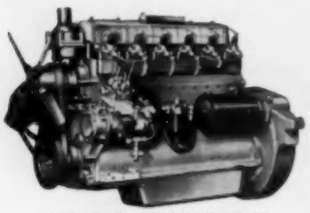
Waukesha Model 180-DLC.



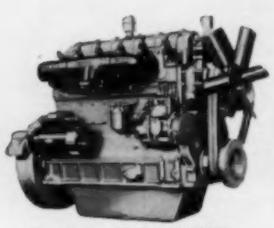
Waukesha Model 185-DLC.



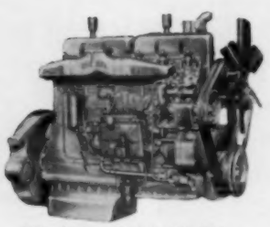
Waukesha Model 190-DLCA.



Waukesha Model 195-DLCA.



Waukesha Model 135-DKB.



Waukesha Model 148-DKB.

of the air, and the rate of burning, are virtually geared to the engine speed. This tends to eliminate sudden, erratic shock pressures, and promotes smooth orderly burning and a moderate rate of pressure rise.

The four-stroke cycle begins when the downward stroke of the piston draws air into the combustion chamber and cylinder. On the upward, second stroke, the moving piston compresses the air in the cylinder into the chamber in a controlled turbulence pattern, due to the tangential positions of the throat and chamber. As the peak of compression approaches, fuel is injected into the air stream, which has been heated by compression and the glowing hot throat and lower half of the combustion chamber, and combustion begins. Turbulence insures an efficient fuel-air mixture and complete, clean burning. The precisely timed injection ends, and the turbulent burning gases expand through the chamber throat into the swirl chambers in the piston crown, starting the piston down on the third stroke. Full power development follows, as the burning gases continue to expand as the piston descends. When this power stroke is nearly complete, the exhaust valve opens at the optimum point and the exhaust gases are forced out of the cylinder on the next stroke, the fourth, or exhaust stroke of the cycle. The heated lower half of the combustion chamber and the chamber throat retains heat to warm the incoming air on the next cycle. Combustion chamber parts can be removed from the outside of the engine without disturbing any other parts.

FRAME is in one piece of special cast iron except for the 2894 cu. in. model—the LRDB. The lower cross members are machined for the crankshaft main bearings. Sides of the frame extend downward well below the crankshaft centerline and have flanges for bolting to the cast iron base or for fastening the oil pan. The upper part of the crankcase, in all models except the LRDB, includes the cylinder block and, as in the separate cylinder block casting of the large LRDB, provides full-length water jackets for the sleeves. In all vertical models, the camshaft is mounted in the upper crankcase space at one side. There is an enclosed space at the side of the block above the camshaft for the valve push rods. In the V-12 model (VLRDB) the camshaft mounts in the center of the "Vee." Feet or pads for mounting the engine are provided on the base or the lower frame or on the attached flywheel housing according to requirements or conditions. The whole frame is strongly ribbed to provide strength and rigidity for maintenance or alignment under working conditions.

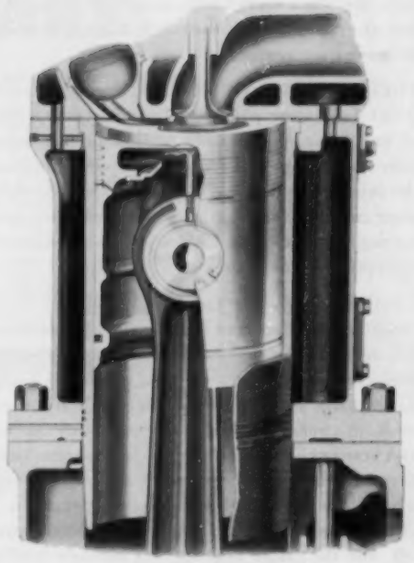
CYLINDER LINERS are removable wet or dry type, depending on model, the wet type being water cooled its entire length. They are manufactured of Waukesha special alloy iron and are carefully honed to extremely fine tolerances.

CRANKSHAFTS are made from steel drop forgings. Journals, pins and webs are substantially proportioned to provide maximum stiffness. Most models are furnished with either standard or counterbalanced crankshafts and torsional vibration dampeners according to service requirements. Main journals and crankpins are hardened to test 600 Brinell or better. Crankshafts are drilled to carry lubricating oil from the main to the crankpin bearings.

MAIN BEARINGS are precision-type steel-backed copper-lead with extra deep bearing caps held by heat-treated alloy steel studs.

CONNECTING RODS are drop-forged from heat-treated alloy steel, and fitted with unusually stout piston pins and heavy-duty steel-backed copper-lead precision-type replaceable crankpin bearings. The upper ends of the rods carry hard bronze bushings for the full-floating piston pins. Bearing caps are heavily ribbed and fitted to the rod with alloy steel heat-treated bolts. In the engines with oil-cooled pistons, the rifle-drilled oil passage in the connecting rod is exceptionally large to provide the cooling oil supply. All rods are carefully balanced and installed in precision-matched sets.

PISTONS are aluminum alloy in all models. A cooling chamber beneath the crown of the oil cooled pistons is regularly supplied with fresh oil from the pressure jets at the top of each connecting rod. This cooling oil, fed in metered quantities under pressure, floods the under side of the piston crown, and is retained by an insert dam to submerge the surface behind the ring grooves. In this way the cooling oil does double duty, cooling the rings and ring area as well as the piston head. Hollow piston pins are



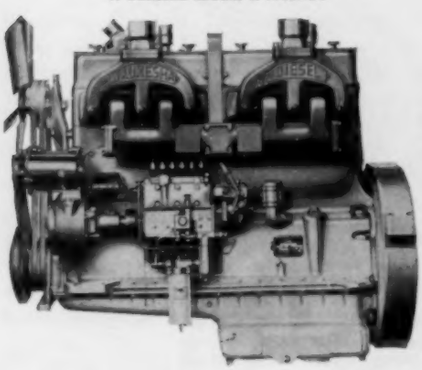
Cutaway view of cylinder and piston showing the hollow piston pin, piston rings, oil-cooled piston head, and ring cooling oil dam.

of large diameter, of steel case-hardened and ground, and of full floating type. Piston compression rings are wedged shaped with top ring chrome faced. Straight side oil control rings are standard. On some models two oil rings are fitted, one above and one below the piston pin.

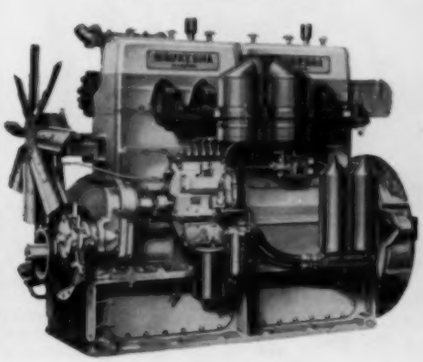
CYLINDER HEADS are cast iron in one piece for the small cylinders, in two interchangeable pieces for the intermediate sizes, and individual castings are used for the largest size cylinders. They carry the combustion chamber, valves and upper valve mechanism. Combustion chamber with its fuel injector is set at an angle at one side to be outside of the valve and valve gear enclosure. Chrome-silicon alloy intake and exhaust valves and hardened alloy valve seats are used in all Waukesha Diesels. In the medium and large size engines both valves have double springs. Brackets bolted to the top of the heads carry the valve rocker fulcrum pins. Easily removable covers enclose the valve ends and valve gear on top of the heads. Valve rockers are actuated from the camshaft by hollow push rods.

CAMSHAFT is a single forging of hardened steel

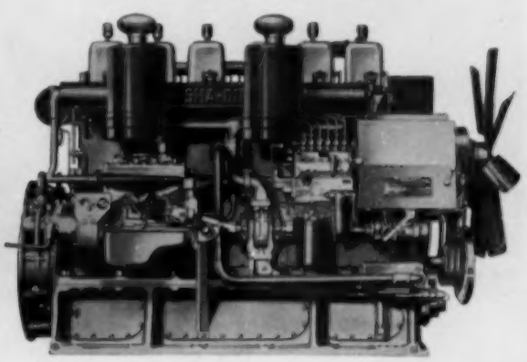
Waukesha Model WAKDB.



Waukesha Model NKDB.



Waukesha Model LRDB.



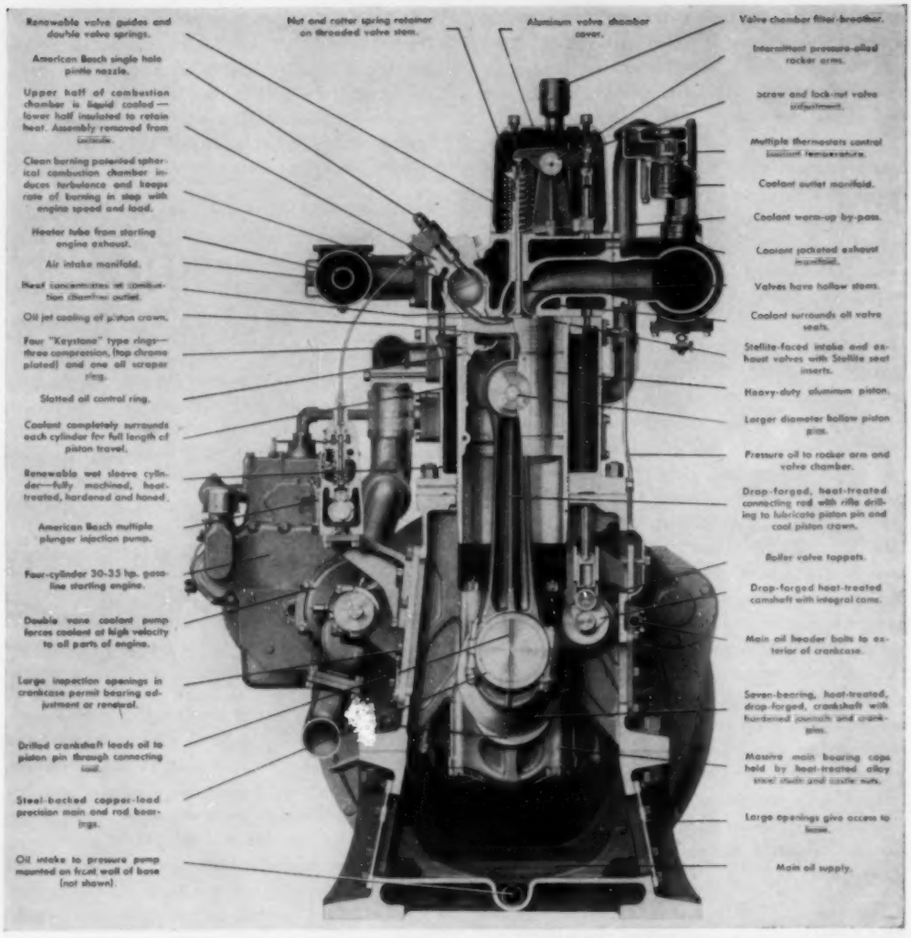
with the cams integral. Camshaft is driven by helical gears from the crankshaft. Same gear train drives the accessories.

FUEL INJECTION is by an American Bosch direct gear-driven pump unit mounted at the side of the engine. Single orifice pintle type fuel injection nozzles are used. A primary pump supplies the injection pumps and a pre-filter and secondary filter are fitted. Single plunger type pumps are used on engines to 426 cubic inch displacement and multiple-plunger pumps on the larger models.

LUBRICATION for the 180-DLC engine is by combination of pressure feed, metered intermittent jet, and spray. Main bearings have direct pressure feed. Intermittent metered jets, accurately timed to discharge into the connecting rod bearings on each up-stroke, provide positive lubrication for rod bearings and pins, while the same intermittent feed lubricates the gears, rocker arms, and valves. Pistons, cylinders and piston pins operate in a continuous mist created by the crankshaft throw-off. For the larger engines, full pressure feed is used for all bearings and parts. Cooling oil for the pistons is taken from the circuit by jets at the top of the connecting rods. Gears are flood oiled. Pressure feed to the rocker arms is intermittent.

All engines operate with the oil in the sump in the pan or base. Positive displacement pressure pumps are outside-mounted on the 779, 1197, 2894, and 5788 cubic inch displacement models, and inside-mounted on all other models. All pumps are gear driven, and take the oil through intake screens in the sump. Included are filter, and on larger engines, cooler, oil pressure and oil temperature viscosity gauges.

COOLING WATER is circulated by a V-belt driven pump mounted on the front of the cylinder block on the three smallest engines. On all engines larger than Model 135 DK, except the V-12, the pump is mounted on the side of the crankcase and is gear driven. Dual gear-driven pumps, one for each bank of cylinders, are used on the V-12 model VLRDB. Radiator fan, when used, is driven by V-belt from the crankshaft pulley. Thermostatic by-pass valve assists quick warm-up and maintains jacket heat. Inside the engine jackets, the cooling water is forced at high velocity in directed paths to the vital areas to scour the surfaces and prevent scale deposits.

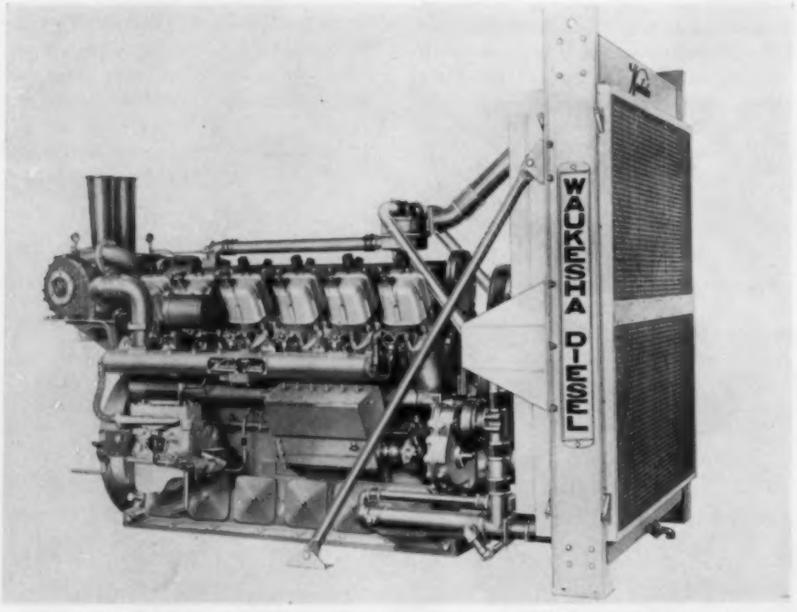

Renewable valve guides and double valve springs.
American Bosch single hole pintle nozzle.
Upper half of combustion chamber is liquid cooled — lower half insulated to retain heat. Assembly removed from cylinder.
Clean burning patented spherical combustion chamber induces turbulence and keeps rate of burning in step with engine speed and load.
Heater tube from starting engine exhaust.
Air intake manifold.
Heat concentrates at combustion chamber outlet.
Oil jet cooling of piston crown.
Four "Keystone" type rings—three compression, (top chrome plated) and one oil scraper ring.
Slotted oil control ring.
Coolant completely surrounds each cylinder for full length of piston travel.
Renewable wet sleeve cylinder—fully machined, heat-treated, hardened and honed.
American Bosch multiple plunger injection pump.
Four-cylinder 30-35 hp. gasoline starting engine.
Double vane coolant pump forces coolant at high velocity to all parts of engine.
Large inspection openings in crankcase permit bearing adjustment or renewal.
Drilled crankshaft leads oil to piston pin through connecting rod.
Steel-backed copper-lead precision main and rod bearings.
Oil intake to pressure pump mounted on front wall of base (not shown).
Nut and cotter spring retainer on threaded valve stem.
Aluminum valve chamber cover.
Valve chamber filler-breather.
Intermittent pressure-oiled rocker arms.
Screw and lock-nut valve adjustment.
Multiple thermostats control coolant temperature.
Coolant outlet manifold.
Coolant warm-up by-pass.
Coolant jacketed exhaust manifold.
Valves have hollow stems.
Coolant surrounds all valve seats.
Stellite-faced intake and exhaust valves with Stellite seat inserts.
Heavy-duty aluminum piston.
Larger diameter hollow piston pins.
Pressure oil to rocker arm and valve chamber.
Drop-forged, heat-treated connecting rod with rifle drilling to lubricate piston pin and cool piston crown.
Roller valve tappets.
Drop-forged heat-treated camshaft with integral cams.
Main oil header bolts to exterior of crankcase.
Seven-bearing, heat-treated, drop-forged, crankshaft with hardened journals and crankpins.
Massive main bearing caps held by heat-treated alloy steel studs and castle nuts.
Large openings give access to base.
Main oil supply.

Cross section of typical Waukesha diesel engine with captions showing important construction features.

STARTING is by electric motor in the smaller sizes, and by electric motor or gasoline engine or air starter in the larger sizes. For cold weather, Chevron starting is standard, or glow plug and intake heater may be used if specified by the purchaser. The gasoline engine when used for starting is arranged to provide a high degree of exhaust heat, led through welded "fire tube" in the Diesel air intake manifold, to insure a quick start in cold weather. Gear train for cranking is enclosed and runs in oil. Manual clutch and automatic starting pinion are provided with the usual anti-backfire and over-speed devices.

OTHER EQUIPMENT includes a centrifugal governor, mounted either on the injection pump assembly or driven from the engine gear train and a water-cooled exhaust manifold on the larger engines; air intake cleaner; controls and instruments; and standard SAE flywheel housing connections.

EXTRA EQUIPMENT available includes such items as radiators with fans, protective hoods, protective devices for temperature and pressure, generators and starting motors and controls, tachometers and pyrometers, and heavy-duty clutch power take-off.



Waukesha turbo-supercharged Diesel complete power unit—Model VLRDBSU, 5788 cu. in. displacement. Develops 1097 hp. at 1200 rpm.

POWER RATING CHART

A complete tabulation giving dynamometer horsepowers . . . complete speeds and loads

RATING TEST CONDITIONS—The *engine* ratings shown are for standard stripped engines without accessory power consuming devices.

The ratings are corrected to standard conditions of 29.92 inches barometer and 60° F. air temperature. A deduction of 3% for each 1000 feet of altitude above sea level and 1% for each ten degrees of temperature above 60° F. should be allowed in all cases except from continuous duty ratings when a deduction for altitude is not necessary below 3000 feet.

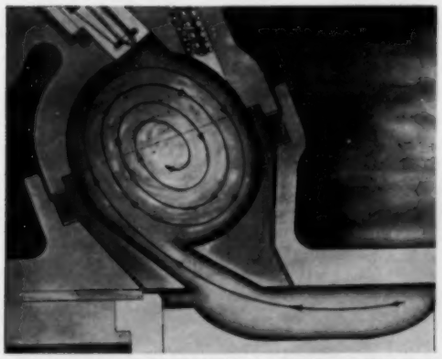
PERMISSIBLE SPEEDS—Speeds to the left of the dividing line are permissible for continuous service; speeds to the right of the line are permissible for intermittent service.

HORSEPOWER—Horsepower ratings shown are maximum ratings. For continuous full load service at a given speed, use 80% of the power shown at that speed; for intermittent service use 90%.

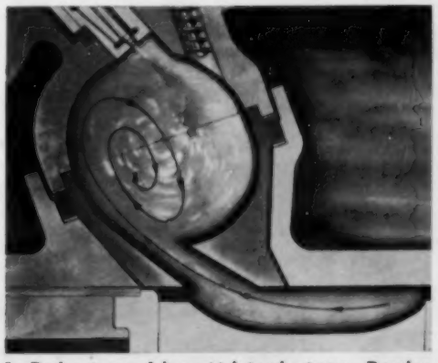
All the ratings and recommended reductions shown here are in accordance with the practice approved and standardized by the Internal Combustion Engine Institute of which the Waukesha Motor Company is a founding member.

MEDIUM DIESEL ENGINES					800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200
MODEL	Features*	Bore & S.	Displ.	Torque–rpm	BRAKE HORSEPOWER AT SPEEDS INDICATED												
180-DLC	4-AC	3½x3¾	144	102-1800	13	18	22	27	31	35	38	42	45				
185-DLC	6-A	3½x3¾	216	152-1000	23	29	34	40	45	50	55	58	60				
190-DLC	6-A	3¾x4	265	191-1400	27	35	43	51	58	65	72	79	84				
190-DLCA	6-AC	3¾x4	265	191-1400	27	35	43	51	58	65	72	79	84	85	84		
195-DLC	6-A	4 x4	302	221-1800	30	39	49	58	67	76	84	91	96				
195-DLCA	6-AC	4 x4	302	221-1800	30	39	49	58	67	76	84	91	96	98	98		
135-DK	6-A	4¼x5	426	328-1600	44	58	73	87	100	113	124	133	140				
135-DKB	6-ACV	4¼x5	426	328-1600	44	58	73	87	100	113	124	133	140	144	147		
135-DKBS	6-ACTV	4¼x5	426	400-1800	...	...	87	104	120	137	151	164	173	180	185		
148-DK	6-AV	5¼x6	779	584-1000	88	111	132	151	169								
148-DKB	6-ACV	5¼x6	779	584-1000	88	111	132	151	169	184	197	200-2100					
148-DKBS	6-ACTV	5¼x6	779	706-1800	...	...	150	181	213	242	268	280-2100					
WAKD	6-AV	6¼x6½	1197	840-1000	126	160	189	201-1300	220-1500								
WAKDB	6-ACV	6¼x6½	1197	845-1000	128	161	193	221	244	258							
WAKDBS	6-ACTV	6¼x6½	1197	1062-1600	...	...	225	276	324	352							
LARGE DIESEL ENGINES					600	700	800	900	1000	1100	1200						
NKDB	6-ACV	7 x8¼	1905	1383-600	158	184	209	234	258	280	297						
NKDBS	6-ACTV	7 x8¼	1905	1730-1000	154	204	245	288	330	362	390						
LRDB	6-ACV	8½x8½	2894	2140-600	245	283	320	350	376	400	415						
LRDBS	6-ACTV	8½x8½	2894	2540-1000	280	333	385	435	485	528	570						
VLRDB	12-ACV	8½x8½	5788	4330-600	495	572	640	700	750	800	830						
VLRDBS	12-ACTV	8½x8½	5788	5070-900	560	665	770	870	960	1050	1135						

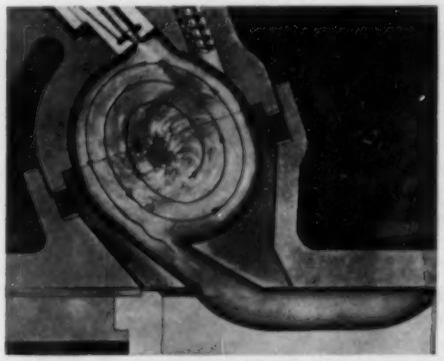
*FEATURES: 4, 6, 12—No. Cylinders; A—Aluminum Pistons; C—Counterbalanced; T—Turbocharged; V—Vibration Dampner.



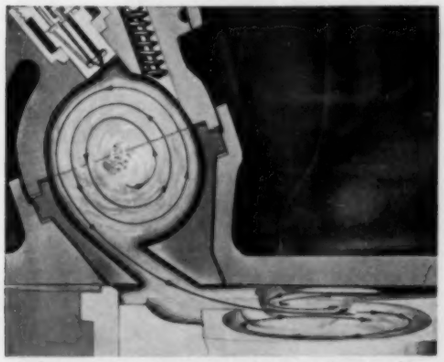
1. Compression nears peak. Heated air rotates in controlled turbulence.



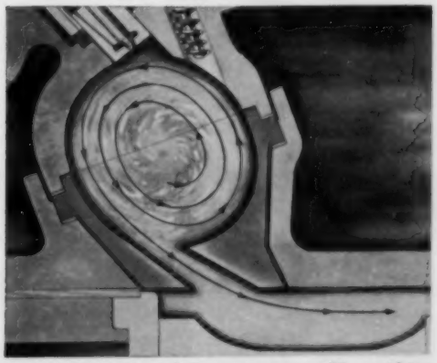
2. Fuel enters and is swept into air stream. Burning starts.



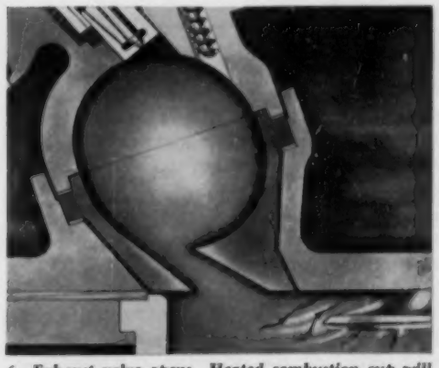
3. Charge in chambers burning. Turbulence insures efficient mixing.



4. Injection ends. Gases enter swirl chambers in piston. Full power developed.



5. Expanding gases deliver power smoothly as piston descends.



6. Exhaust valve opens. Heated combustion cup will warm new air on next cycle.

***WAUKESHA DIESEL COMBUSTION SEQUENCE.** Combustion is controlled, and takes place in well defined steps or stages, to prevent excessive peak pressures and to permit a wide choice of fuels ranging from 45 cetane upward. These engines have the same smoothness and quick pick-up commonly associated with gasoline engines and characteristic of all Waukesha Diesel Engines.*

GENERAL MOTORS

DETROIT DIESEL ENGINE DIVISION

TWO-CYCLE DIESEL ENGINES

GENERAL Motors Detroit Diesel two-cycle Diesel engines are offered in various standard models ranging from 30 to 893 horsepower for industrial, oil well drilling, marine and vehicle applications.

They are available both with or without General Motors torqmatic converters installed as an integral part of the unit. In all models symmetrical design permits the location of engine accessories on either side of the engine as dictated by space and other installation factors. Crankshaft rotation in either direction is also available.

Because of their two-cycle design General Motors Diesel engines are comparatively smaller in size and lighter in weight than most other Diesel engines of like horsepower. They have electrical or hydraulic starting systems and start on Diesel fuel. Since the Detroit Diesel Engine Division began operation in 1937 engines totalling over 71,000,000 horsepower have been produced in the "71", "110" and "51" series.

Marine engines have built-in reverse and reduction gears with a choice of reduction gear ratios. All models except the "4-51" and three and four cylinder series 71 models have the General Motors hydraulic reverse and reduction gear as standard equipment. Front power take-offs with direct drive or reduction gears are provided. Standard equipment includes all items necessary to make these engines complete power plants. Optional equipment includes variations in cooling equipment, but all engines are cooled on a closed system.

Series 71 Engines

Detroit Diesel Series "71" engines are built in two-, three-, four-, and six-cylinder units with four and six-cylinder engines also available as "Twins." Six-cylinder engines are also mounted together as "Quads." The "Twin 4," "Twin 6" and "Quad-6" units having eight, twelve and twenty-four cylinders, respectively, each turn a single power-output shaft. Engines in the twin units are mounted either side-by-side or end-to-end. The end-to-end mount—or Tandem Twin—is especially adaptable for use in large pleasure craft or work boats. They offer a wide range of flexible power as any one or more engines in these multiple units may be declutched at will when less power is needed for lighter loads or to maintain the operation while engines are being serviced. The bore and stroke of the cylinders in all series "71" single or multiple engine models is 4¼ by 5 inches. These two-cycle engines have uniflow scavenging, General Motors unit fuel injectors and have a compression ratio of 17 to 1.

The symmetrical design and interchangeability of parts on all models, renewable surfaces wherever wear occurs and unit sub-assemblies repairable or replaceable without major engine tear-down are features contributing to lower parts inventories, lower upkeep costs and longer engine life.

Details of the interior construction and variations in the outward form and overall assembly are well shown in the illustrations given here.

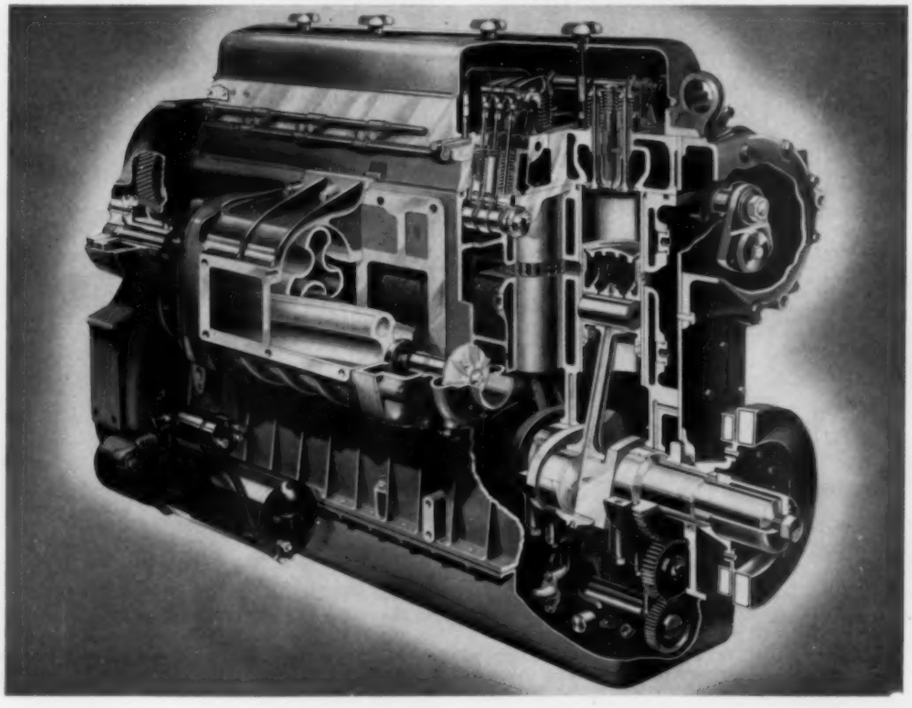
CYLINDER BLOCK AND CRANKCASE is a one-piece casting of alloy iron and is the main structural part of the engine. Rugged transverse members, cast integral, provide utmost rigidity and strength to insure permanent alignment of bores and bearings under all load conditions. Main bearing caps are attached to the crankcase and machined in place to fit the precision bearing shells. Both ends of cylinder block are absolutely identical so that the flywheel housing and gear train can be put on either end, depending upon the desired arrangement of accessories. Blocks for three, four and six cylinder engines are similar except for the necessary changes in length. Water jackets extend full length of bores and are divided into upper and lower sections connected by hollow struts. The air chamber or air box surrounding the water jacket conducts the air from the blower to the inlet ports. Drilled passages in the block carry lubricating oil to all moving parts and eliminate external piping. Handhole covers on the side opposite the blower provide access to the air chamber and permit inspection of pistons and rings through the air intake ports.

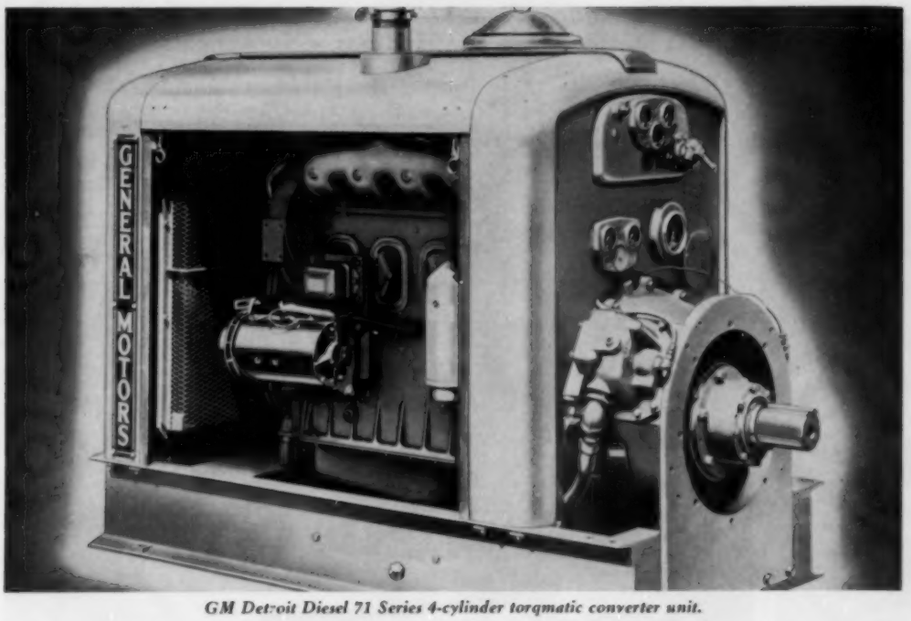
CYLINDER LINERS are easily removable, made of alloy cast iron and accurately honed to a very smooth finish. Flange at top of liner rests on a chilled-and-tempered replaceable cast iron ring which in turn fits into recess in cylinder block, insuring proper positioning in block. Twenty "figure eight" shaped angularly drilled holes serve as air inlet ports.

CYLINDER HEAD is a one-piece alloy iron casting which can be easily removed from the engine as an assembly containing cam followers, guides, rocker arms, exhaust valves, and injectors. Head is securely held to the upper deck of cylinder block by heat-treated alloy steel studs. Located in the head are two exhaust valves, a unit fuel injector, and three drop forged rocker arms for each cylinder. One rocker arm operates the injector plunger and the other two operate the exhaust valves.

GASKETING between the head and block is accomplished by means of individual compressible metal and synthetic rubber rings instead of a single laminated gasket commonly used in head-to-block sealing. The individual metal rings are located directly on top of the cylinder liners and the individual synthetic rubber rings, which resemble ordinary hose washers, fit in recesses around water and oil passages. When the cylinder head bolts are pulled down, metal-to-metal sealing at the head of each cylinder and a more positive leak-proof sealing at the other passages is assured. This sealing method was dependent upon the development of spring-like compressible compression gaskets and the fairly recent availability of synthetic rubber which withstands the heat of such an application and is also impervious to the damaging effects of oil. According to Detroit Diesel Service engineers this method has proven far superior to the single laminated gasket type of sealing.

Perspective cutaway of Basic GM Detroit Diesel Series 71 6-cylinder engine.





GM Detroit Diesel 71 Series 4-cylinder torqmatic converter unit.

CRANKSHAFT is a high-carbon, alloy-steel, drop forging, carefully heat treated to insure utmost strength and durability. Journal and crankpin bearing surfaces are electrically hardened by Tocco process, finish ground and polished to insure trueness of bearing journals. Counterweights are forged integral with crankshaft. Complete static and dynamic balance of rotating parts is achieved through final machining. Crankshaft journal fillets on 3, 4 and 6-cylinder engines are rolled and polished for added strength. End thrust is carried by two-piece washers on each side of the rear main bearing. Crankshaft is drilled for full pressure lubrication to main and connecting rod bearings. Oil seals are provided at front and rear ends. Large main bearing shells of precision type are replaceable without machining or fitting.

CONNECTING RODS are made of heat-treated alloy-steel drop forgings with an "I" section. Rod is rifle drilled for lubrication of upper end which is also equipped with an oil spray jet for cooling of the piston. A steel-backed copper lead piston pin bushing is pressed into the upper end of the rod. Precision-type crankpin bearings can be replaced without machining or shim adjustment.

PISTONS are malleable iron with extra long skirts, accurately ground the full length, and electro-plated with a protective coating of tin. Combustion chamber is formed in top of piston. To add strength and rigidity, head is cast with circular rib on underside which is connected to inner ends of piston pin bosses by vertical struts. Piston head is cooled by lubricating oil sprayed from a jet in top of connecting rod. Two steel-backed copper lead bushings in the piston support the piston pin. Piston pin is full floating type, made of hardened nickel molybdenum steel tubing with ground and lapped outside diameter. It is retained in place by two dished spring-steel disks. All pistons are balanced for weight and may be replaced individually, whether standard or oversize, without upsetting engine balance. There are four 1/8 inch wide steel, chrome-plated compression rings. Below the piston pin are two special 1/4 inch wide oil control rings.

EXHAUST VALVES are heat-treated nickel steel forgings, and stems are accurately ground to close limits and hardened at the ends to provide wear resistance. Valve stem guides are of fine-grained cast iron, replaceable without reaming and pressed into cylinder head. Straight cylindrical valve spring is made of alloy steel and held in place by retainer and tapered two-piece lock. Hardened exhaust valve seats are pressed into cylinder head. Seats are accurately ground to very close limits and their freedom from warpage reduces valve grinding to a minimum.

VALVE COOLING is accomplished by water deflectors of the nozzle type in the cylinder head water passages which direct the flow to the valve seat. In addition, there is cooling from the sweep of the scavenging air past the valves. Therefore, the valves run cool and attention required is reduced to a minimum. The two exhaust passages per cylinder in the head enter a single port at the exhaust manifold. Exhaust passages, exhaust valve seats, and fuel injector seats are completely surrounded by cooling water.

CAMSHAFT is a one-piece alloy-steel drop forging, with case-hardened and ground cams and journals, located near the top of the cylinder block. Cam lobes are wear resistant and are carefully ground to provide surfaces parallel to shaft for efficient, quiet roller action. A steel-backed-copper lead bearing assembly with copper-lead thrust washers on the thrust end, and heat treated aluminum intermediate bearings between each set of cams, provides the necessary rigid support for the camshaft.

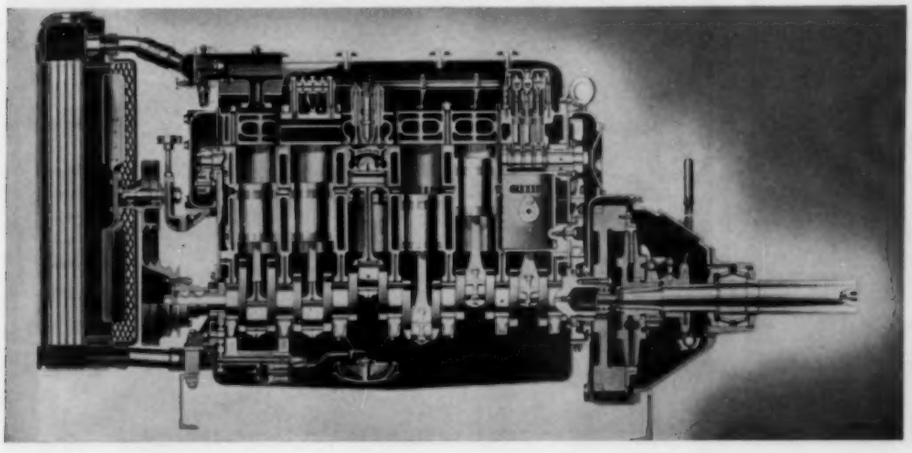
BALANCE SHAFT runs parallel to the camshaft and at the same distance from the crankshaft but on opposite side of cylinder block. Balance shaft is supported in same manner as camshaft except no intermediate bearings are used. End bearings with thrust washers at thrust end are identical with those used on camshaft. Function of balance shaft is to counterbalance the primary rocking couple and thus effect a perfect balance within the engine. Eccentrically positioned weights, at the front and rear ends of both shafts, counterbalance the inertia forces of the reciprocating pistons. Consequently, the engine operates smoothly and in perfect balance throughout the entire speed range.

GEAR TRAIN is located at flywheel end of engine, is completely enclosed, and consists of five helical heat-treated alloy steel gears. Camshaft gear and balance shaft gear mesh with each other and run at the same speed as the crankshaft. Either of these gears may be driven from the crankshaft gear through an intermediate idler gear, depending upon desired arrangement of accessories. Blower drive gear is driven by either the balance shaft gear or the camshaft gear.

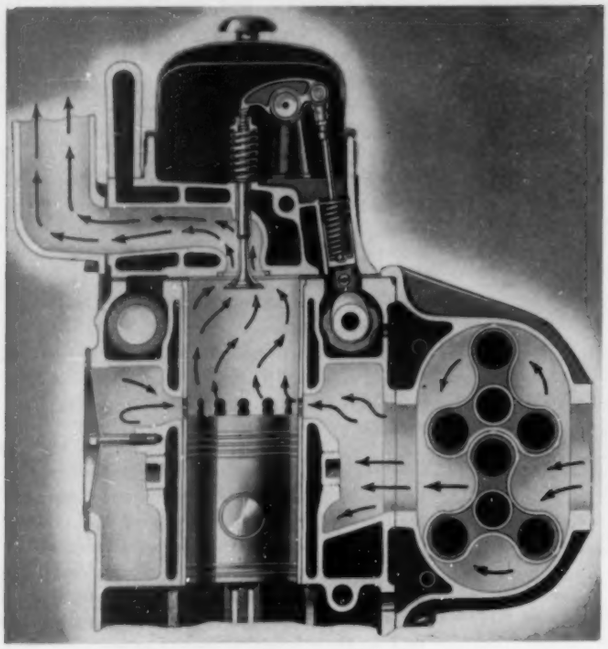
AUXILIARY DRIVE is on blower side of engine, and through blower drive gear transmits power to blower, governor, water pump and fuel pump. Drive is cushioned by spring-loaded, flexible coupling, insuring uniform rotation of blower rotors.

FLYWHEEL is of cast iron, made relatively light due to even power impulses but sufficiently heavy to insure full operating flexibility. Flywheel is bolted to crankshaft flange and doweled in two places. Flywheels and flywheel housings are available to suit any conventional clutch or industrial drive. Starter ring gear of heat-treated steel is

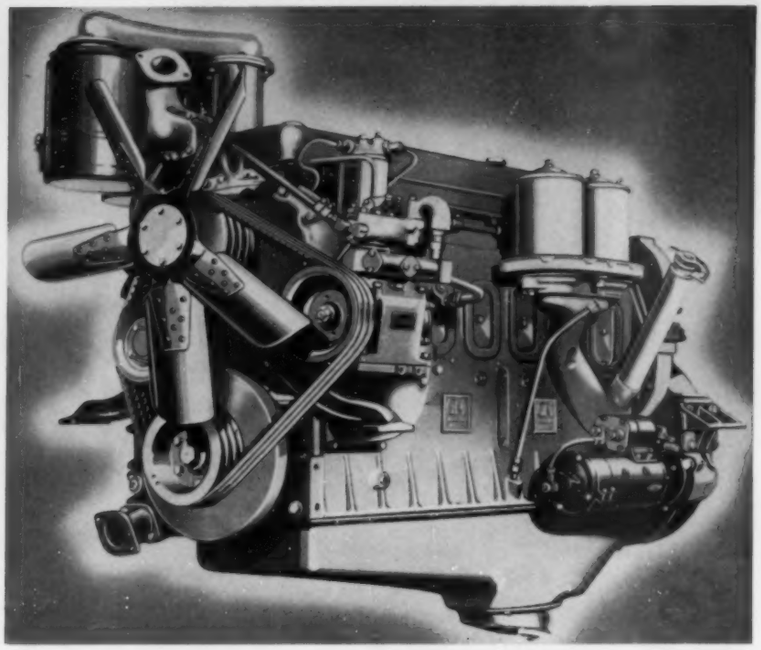
GM Detroit Diesel 6-71 engine.



GM Detroit Diesel Series 71 engine, showing uniflow scavenging.



GM Detroit Diesel Series 71, 6-cylinder truck engine.



shrunk onto rim. The same flywheel can be used on either a right- or left-hand rotation engine.

UNIFLOW SCAVENGING PROCESS used in these two-cycle engines provides for air entering the cylinder through the radially drilled ports in the liner when they are uncovered by the piston near the bottom of its stroke and sweeping out all of the burned gases through the exhaust valves at the top. This scavenging air cools the internal engine parts, particularly the exhaust valves, and at the beginning of the compression stroke, the cylinder is charged with fresh, clean air for the next combustion.

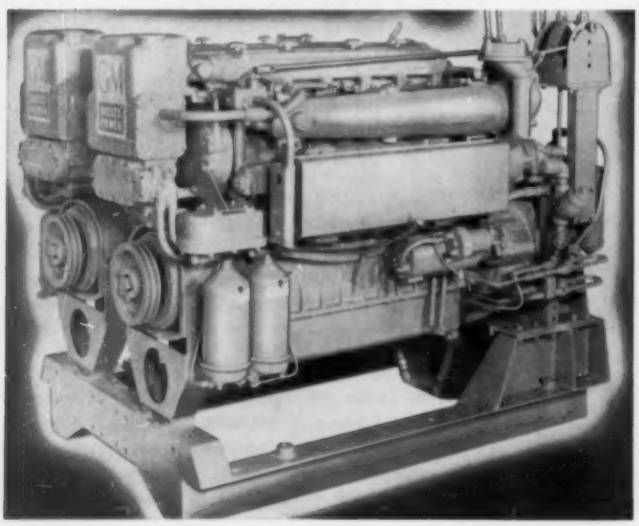
Air is supplied by a Roots-type blower designed especially for this engine. Two rotors, each with three spiral shaped hollow lobes, revolve with very close clearances in a housing bolted to the side of the engine. Air entering the blower inlet from the air cleaner is picked up by the lobes and carried to the discharge side of the blower. Continuous discharge of fresh air from the blower creates an air pressure of about 6 psi in the air chamber of the cylinder block when at maximum engine speed.

GENERAL MOTORS UNIT FUEL INJECTORS accomplish three functions often handled in Diesel engines by heavier and more bulky fuel systems. They meter the exact amount of fuel required for varying loads, create the high pressure needed for efficient injection and atomize the fuel into microscopic particles for instant mixing with air in the combustion chambers. They eliminate the need for high pressure fuel pumps, high pressure fuel lines and delivery valves and reduce the number of drive and timing mechanisms required. Fuel injection pressure is actually confined to a small portion of the injector.

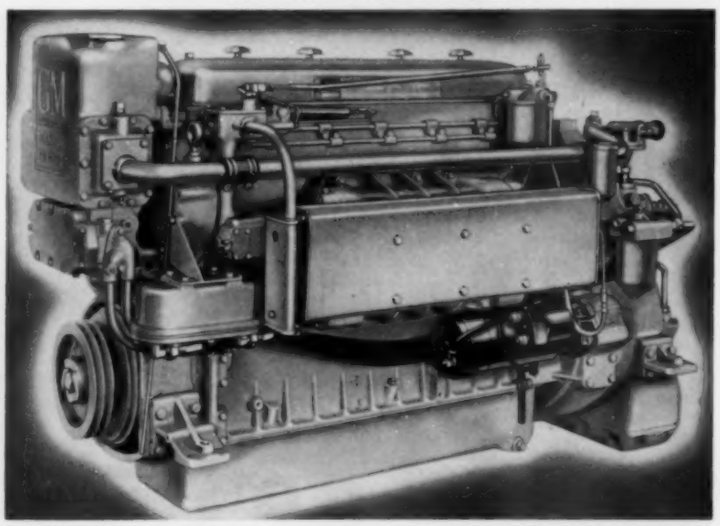
The injectors are located in the cylinder head and are operated by a rocker from the camshaft through roller cam followers and push rods, thus insuring correct timing of the fuel injections. To insure efficient cooling, each injector is inserted in a thin-walled copper tube passing through the cylinder head water jacket. Lower end of copper tube is pressed into the cylinder head and spun over; upper end is flanged and sealed with a Neoprene seal.

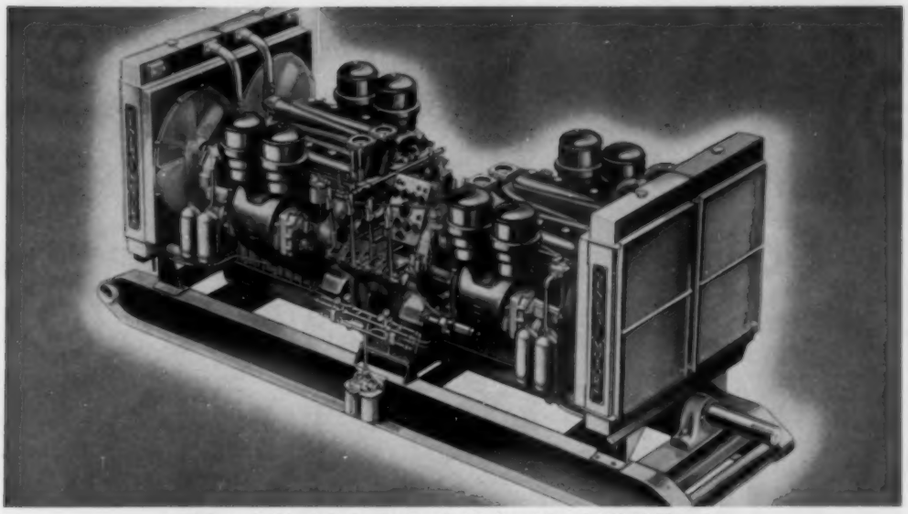
Fuel oil is supplied to the injector at low pressure, and enters the body at the top of the filter cap. After circulating through the injector, fuel leaves by the corresponding parallel filter cap. As ultimate protection against dirt, feed and return line connections of the injectors are equipped with metal strainers. Constant circulation of fuel through the injectors maintains even operating temperatures of the injector parts,

GM Detroit Diesel Series 71 twin 6 marine unit with GM hydraulically operated reverse and reduction gears.



GM Detroit Diesel Series 71, single six marine unit, with GM hydraulically operated reverse and reduction gears.





GM Detroit Diesel Series 71 Quad 6 Industrial and Oil Field engine.

and removes all traces of air which might otherwise accumulate in the system and interfere with the metering of the fuel. No venting of fuel lines or injectors is required at any time. Injectors are readily timed by the adjustment of two counteracting screws on the injector rack control lever. A universal fuel transfer pump of the positive displacement type is driven from the lower blower rotor shaft. A U-shaped steel stamping acts as a universal joint drive. A primary fuel strainer before the fuel pump and a secondary fuel filter between the fuel pump and the injectors thoroughly clean all of the fuel before it enters the injectors.

Design changes in the Series 71 injector, adopted in 1954, moved the injector valve to a higher position to lessen its exposure to cylinder temperatures. Also increased protection against compression pressure and heat was provided for the valve spring through relocation of the check valve. The number of wearing parts in the follower assembly was reduced and the follower spring made heavier and stronger. Parts kits are available to adapt new component parts to the former type injectors without conversion and for converting former-type injectors to high-valve design. The former type injectors may be used with new or converted injectors in an engine in any combination as long as all injectors are of the same nominal capacity.

GOVERNOR is connected to the control shaft running the length of the cylinders, and shaft acts through levers directly on the fuel injector racks, thus controlling the engine speed. Engines may be adjusted to run over a wide range of speeds and will perform equally well with the governor set for any maximum speed from 1200 to 2300 rpm. Governing equipment is available to suit the requirements of all types of service which may be classified according to usage.

Constant Speed Governors hold the engine speed constant or nearly so regardless of the applied load. Speed can be changed slightly either by shims or vernier control, depending upon the type. Variable Speed Governors hold the engine speed constant or nearly so and can be manually adjusted to run at any speed from idle to full speed. Limiting Speed Governors control the idle and the maximum speeds, safeguarding both the engine and the equipment. This governor permits the engine speed to be directly controlled at all intermediate speeds by throttle or manual adjustment.

LUBRICATION is by pressure feed to all surfaces and parts needing it. The oil pan bolted to the bottom of the crankcase acts as a sump. Positive displacement pressure pump is gear driven from the crankshaft and located in the oil pan space. Suction is through a screen, and discharge is through the attached oil cooler and to the distribution passages in the engine. Either full-flow or by-pass type filters are available.

COOLING WATER is circulated through the jacket spaces by an attached circulating pump. Flow of water through jackets is so directed as to give nearly uniform metal temperatures. Heat collected by lubricating oil from bearings and cooling oil from underside of pistons is transferred to cooling water in the oil cooler. Heat is removed from the cooling water, which circulates on a closed system, by either a radiator or heat exchanger. Complete systems are available to suit all installation requirements. Available as an optional accessory for all engines is a water filter, which removes impurities from the cooling system, softens the cooling water and controls alkalinity, rust formation and electro-chemical action.

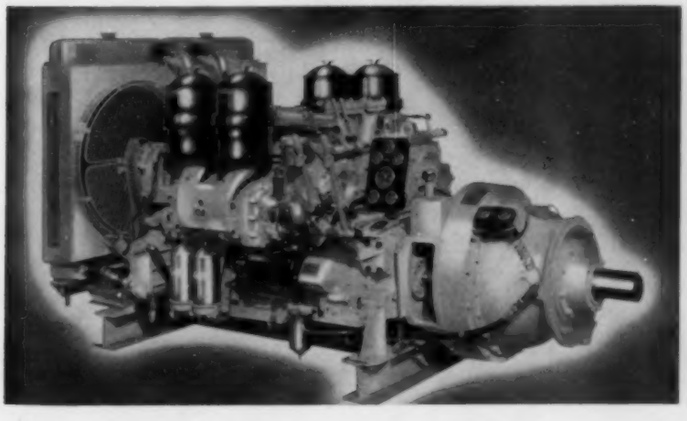
STARTING SYSTEMS include push button electric starters and battery charging generators. Prompt starting is insured at all temperatures. Starting in temperatures below 40° F is insured either by spraying starting fluid through a nozzle in the blower air intake casing or by air box heaters equipped with fuel oil nozzle and ignition points. No ignition points are used with starting fluid. Both systems are equipped with a hand pump located on the instrument panel. These two systems are alternate; only one is used on an engine.

Now optional on Detroit Diesel engines is a new starting system that eliminates the use of batteries. The unit, called the General Motors Hydrostarter, is entirely hydraulic in its operation. Its efficiency is not affected by temperature, humidity or altitude. In zero temperatures, for instance, the unit attains cranking speed almost instantly.

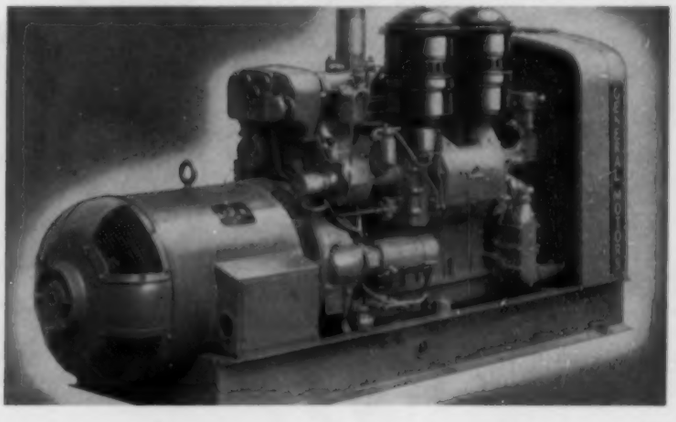
At the press of a lever gas pressure built up behind a piston in a factory-sealed accumulator cylinder forces oil through a hydraulic starting motor. When the engine starts, an engine-driven pump forces the oil back into the cylinder, recompressing the gas and the unit is thus automatically recharged for the next start.

The initial charge is accomplished by means of

GM Detroit Diesel Series 71 Twin 6 industrial and oil field power unit with GM torqmatic converter.



GM Detroit Diesel Series 71 Diesel portable generator set.



a hand pump. The unit is then self-sustaining, but the hand pump is available for recharging the cylinder if it should become necessary. This pump can also be used to advantage in "rolling" the engine slowly to various positions when valve, injector or other engine adjustments are made.

These starting systems allow maximum economy on jobs where power demand is intermittent. It is cheaper and better not to idle engine but stop it until power is needed again. Full power is available promptly after starting.

"TWINS" AND "QUADS" are available with accessories on either side, assembled on a common base and connected to a transfer gear box with a single output shaft. Each engine has its own cooling, lubrication, and fuel system, as well as a separate clutch. Multiple engine units are outstanding in their wide range of power output and engine speed. A unit may be economically and efficiently operated on one or more engines, depending upon the power requirements. In addition, an individual engine may be serviced without interrupting operations. Again, in case of need, even though one or more engines have been dormant for some time, they can be started and placed under load promptly. Thus these multiple units offer advantages of great flexibility in operation.

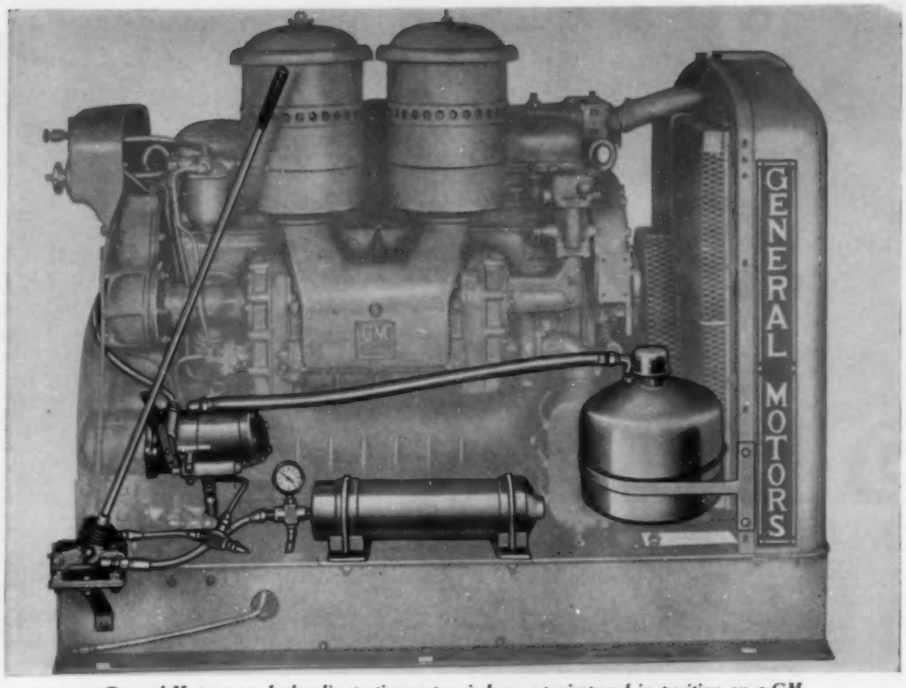
ENGINE RATINGS depend upon many factors. Power developed depends upon quantity of fuel injected per stroke, and maximum power depends upon capacity of the injectors. Ratings for continuous service are chosen for economical operation and durability, well below the maximum rating. Intermittent ratings are above the continuous ratings and still well below the maximum power output.

Series 71 engines perform well over a wide speed range. Engine speed for continuous duty may be chosen anywhere between 1200 and 1800 rpm. Intermittent duty service has the characteristic quick response and dependable power at any speed between 800 and 2300 rpm. Speed of equipment may be varied by direct throttle control, and meets the requirements of operating equipment subject to wide ranges of load and speed fluctuations. Large capacity fuel injectors can be fitted to further increase the reserve capacity when required.

CONTINUOUS RATING for Series 71 engines has the same output per cylinder for the entire series regardless of the size of the injectors. The B.M.E.P. rating is approximately 80 psi (without fan or generator).

INTERMITTENT RATING with 60 cu mm (quantity of fuel injected per stroke) injectors allows for a reserve above the continuous rating. This reserve is ample for most installations because they operate at or below the continuous rating. The limited capacity of these injectors not only protects the connected machinery from damage but insures good economy and long life under any load conditions.

Increased reserve power for applications which have intermittent peak loads requiring more power is obtained by using either 70 or 80 cu. mm. injectors. The use of 80 mm injectors is recommend-

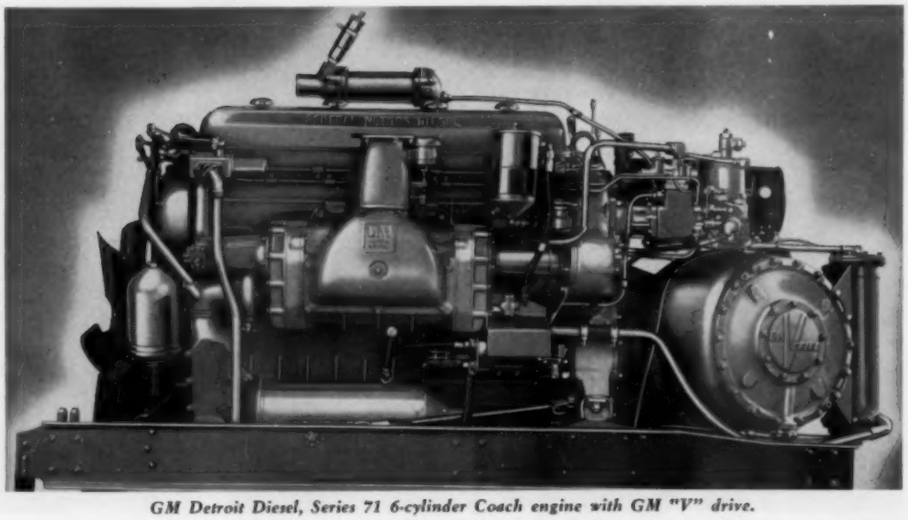


General Motors new hydraulic starting system is here superimposed in position on a GM Detroit Diesel engine. The parts shown (left to right) are: manual pump, starter motor, pressure gauge, factory-sealed pressure accumulator and oil reservoir. The small engine-driven pump is installed at rear of engine (out of view in this photo). Accumulator cylinder, hand pump and oil reservoir can be positioned either on or off engine to meet installation requirements.

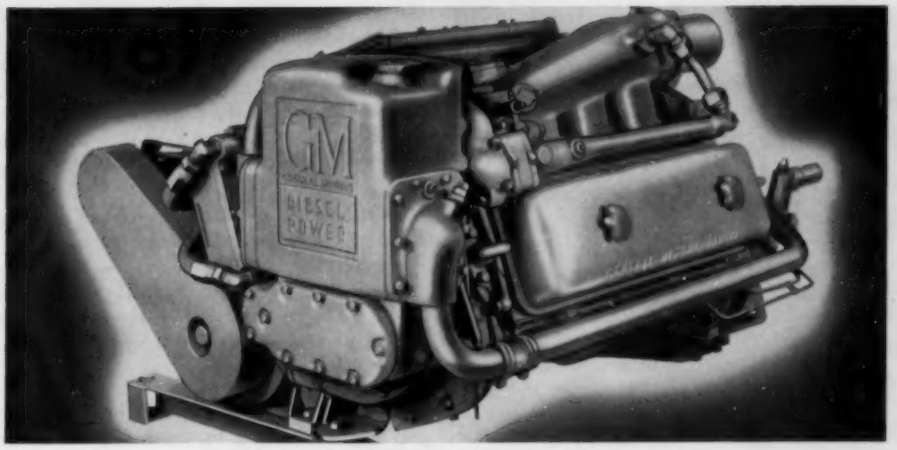
ed by Detroit Diesel only for pleasure craft and certain other high-speed marine applications. In the interest of efficient operation and long life, Series 71 engines fitted with 70 cu. mm injectors are conservatively limited to less than 80 per cent of the possible maximum power output.

INDUSTRIAL POWER AND MARINE PROPULSION UNITS are offered in a variety of forms including variations in accessories and equipment to meet the varying needs of individual applications. Open or enclosed (in a hood) long base industrial engines provide a power take-off clutch with a long drive shaft with outboard bearing supported by the base extension. Open or closed short base engines provide a power take-off clutch with short extension shaft. Engines are supplied in fan-to-flywheel arrangement, or with radiators, or with heat exchangers for cooling without the fan. Eight basic models of engines can be built based upon arrangement of attached accessories and direction of crankshaft rotation. Engines can be supplied with General Motors torqmatic converters for industrial applications or with General Motors hydraulically operated reverse and reduction gears for marine propulsion units. Three- and four-cylinder engines for small craft are offered without heat exchangers and with through-shaft, direct drive marine gears as standard.

INCLINED DIESELS for use as marine propulsion engines are available in four- and six-cylinder models. These engines are adaptations of the Division's standard Series 71 models. With blocks and heads tilted 70° from the vertical the installation heights of these engines are six and eight



GM Detroit Diesel, Series 71 6-cylinder Coach engine with GM "V" drive.



GM Detroit Diesel inclined Series 71, 4-cylinder Marine engine.

inches, respectively, less than the vertical engines of the same capacity. Through extensive use of aluminum alloys they are up to 500 pounds lighter in weight. Because of their reduced height and weight and excellent hull conformation they are particularly adaptable for use in pleasure craft and "crew boats." The engines are available in both right- and left-hand rotation. In either case accessories and servicing points are located on the upper part of the engine where they are readily accessible. They have three-point suspension with each contact point cushioned in rubber. The engines are provided with General Motors hydraulically operated reverse and reduction gears. With accessories the 4-cylinder model is rated at 151 SHP at 2500 RPM while the 6-cylinder unit is rated at 235 SHP at the same RPM.

DIESEL GENERATOR SETS are supplied with direct driven AC or DC generators all mounted on welded steel bases. One group of these units designed for standby and off-the-line applications includes the control cabinet with all instruments mounted right on the skids above the end of the generator. Radiator or heat exchanger cooling may be provided. Another group includes heat exchanger cooled units with DC or AC marine generators for marine auxiliary applications. All of these generator sets have hydraulic governors for accurate control of voltage and frequency. Standard capacities range from 20 to 245 kw.

THE GM DETROIT DIESEL SERIES 110 ENGINE

The Detroit Diesel 6-110 two-cycle diesel engine was developed through years of research and testing by Detroit Diesel Engine Division to meet the increasing horsepower requirements of large earth-moving vehicles, tractors, oil field, general industrial and marine equipment. It is designated as the "110" because of its 110 cubic inch displacement per cylinder and is manufactured only in the six cylinder size.

Like the Series 71 engine the 6-110 now employs uniflow Roots blower scavenging which provides an improved overall design arrangement of accessory locations with provision for added accessories. Flexibility is realized also with the Roots blower since it can be mounted on either side of the cylinder block. Pressurized air flows from the blower through radially-drilled ports in the cylinder liner at the bottom of the piston travel. Residual exhaust gases are thus forced upward and out through the in-head exhaust valves and the cylinders are charged with fresh air for combustion.

This engine embodies the same advanced principles of high-speed two-cycle design as the "71" series and like the "71" series it combines one of the American Diesel industry's highest power-per-pound ratios with great smoothness and economy of operation and maintenance.

The rated horsepower of this engine with standard power unit accessories and 110 cu. mm. injectors is 274 at 2000 rpm. Bore and stroke is 5 x 5.6. Piston travel is 1680 feet per minute at 1800 RPM, maximum continuous rated speed. Compression ratio is 18 to 1.

GM Unit Injectors (one for each cylinder) pressurize, meter and atomize the fuel. Although of larger capacity than those used in the Series 71 engine, the operating principles are the same.

Cylinder block and head of the 6-110 are one-piece castings, both being symmetrical about a vertical plane between Number 3 and Number 4 cylinders. This symmetry allows the cylinder head and block to be reversed, giving a choice of rotational direction and making possible a variety of accessory locations to suit installation requirements.

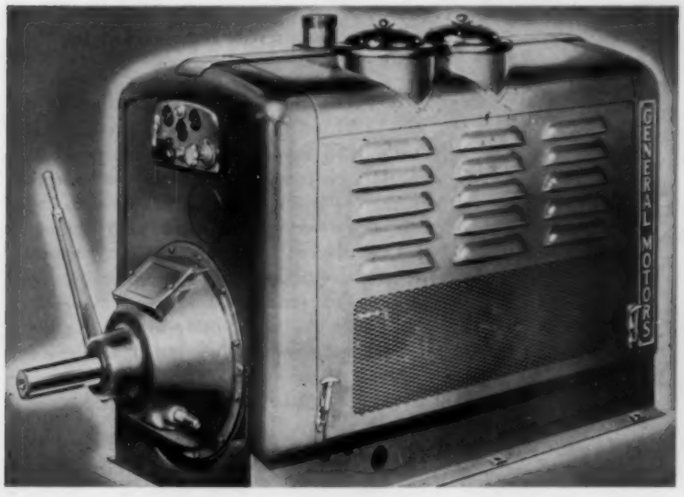
The water manifold is cast integrally with the cylinder head, thus eliminating the need for a separate water manifold, attaching studs and gaskets.

Cast water outlet openings are cast symmetrically at each end of the head to allow reversing the head for different accessory arrangements. A peripheral rail on the top deck gives a strong rigid head and allows the use of a shallow rocker cover.

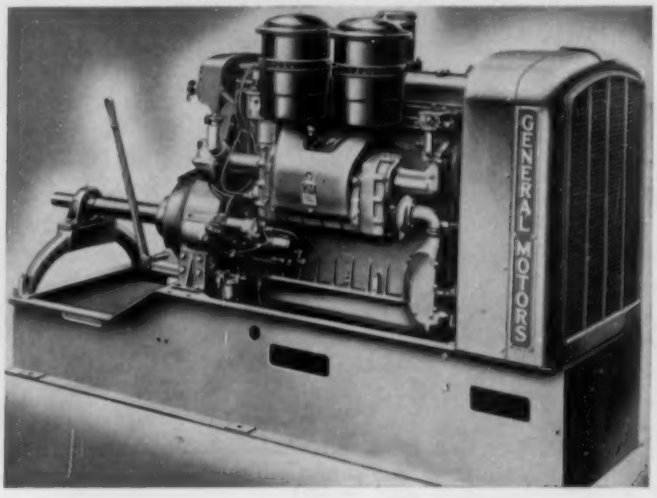
The engine is of rugged heavy-duty construction throughout. All wearing parts such as cylinder liners, bearing, valve guides and inserts are precision parts and are readily replaceable, which adds to engine life and to ease of repair. Large main bearing and crankshaft journals assure long bearing life. As an example of the heavy-duty design employed, the seven main bearing crankshaft journals are of four-inch diameter; the connecting rod journals three and one-half inches.

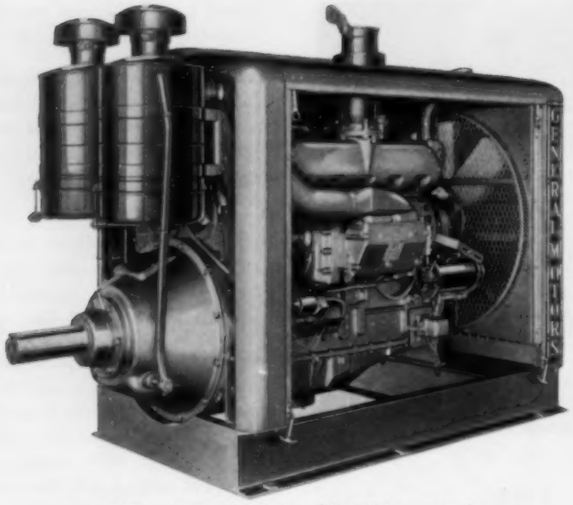
Use of a 1-5-3-4-2-6 firing order for RH rotation and 1-6-2-4-3-5 firing order for LH rotation, together with two-cycle operation, assures a smooth running, inherently well-balanced engine. Two small crankshaft counterweights at each end and two near the center of the crankshaft are all that are necessary, and these only to equalize bearing loads.

GM Detroit Diesel Series 71 industrial short base power unit.

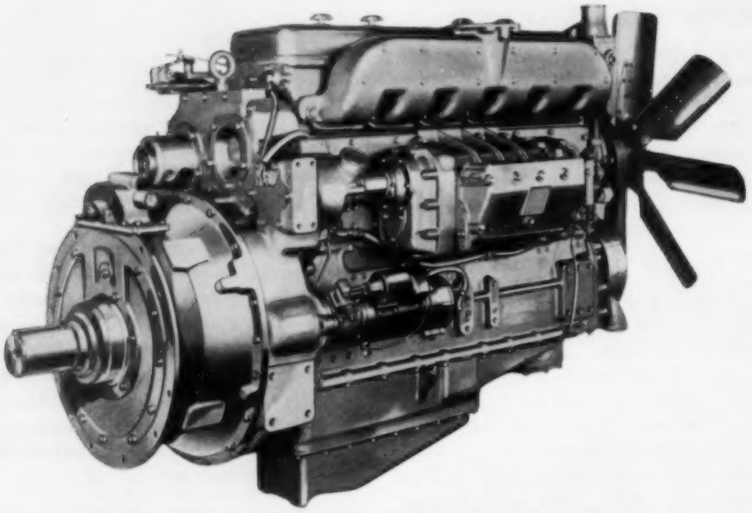


GM Detroit Diesel Series 71 long base industrial power unit.

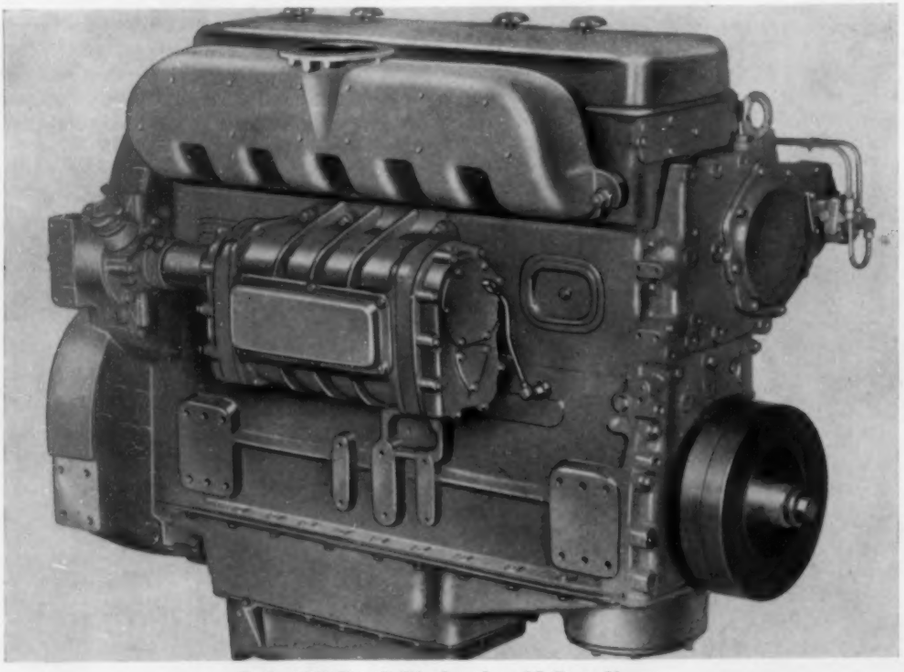




GM Detroit Diesel 6-110 model 62406 power unit.



6-110 GM Detroit Diesel Model 62306 with torqmatic converter.



Basic 6-110 Detroit Diesel engine with Roots blower.

To further insure smoothness of operation and reduce crankshaft stresses, a viscous type damper is used on the front end of the crankshaft. This damper consists of two damper units bolted to a common hub which is retained on the crankshaft by an inner and an outer cone, the cones being secured in place by a crankshaft cap or accessory pulley. Each damper unit consists of an inertia mass enclosed in a fluid-tight outer case but separated therefrom by a thin wall of viscous liquid having characteristics of little response to temperature changes. Any movement in the inertia mass is resisted by the friction of the liquid. This tends to dampen excessive torsional vibrations in the crankshaft.

The even torque of the 6-110 engine permits the use of a relatively light cast-iron flywheel. To the flywheel rim is shrunk a starter ring gear. The starter is a 24-volt or 32-volt four-pole, Dyer or Bendix drive type.

As in the Series 71 engines the cam shaft is placed near the top of the engine block, allowing for relatively short push-rods for valve and injector operating mechanisms.

The exhaust manifold is of cast iron or fabricated steel. Exhaust outlet may be at either end or in the center of the manifold depending on requirements of the installation.

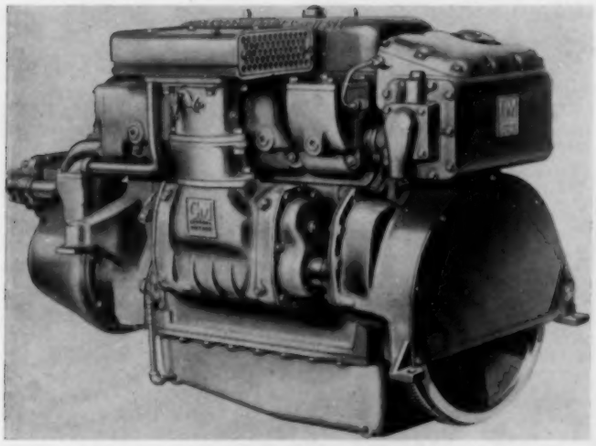
The customary forced feed lubrication is provided, with a gear-driven pump delivering 45 gallons per minute at 1800 RPM. The oil gallery is a separate tube cast in the cylinder block, eliminating long-hole drilling operations. Oil pans have removable bottom cleanout covers. Pistons are triple-cooled with water, oil and air.

The 6-110 engine is furnished with quick-acting limiting speed or variable speed governors similar to those on the "71" Series of engines.

The "110" is offered (a) as a bare engine, (b) with full equipment for marine or industrial use or (c) with special accessory arrangements for a variety of end products. Optional accessories, which may be powered directly from the gear train, include a hydraulic steering pump and an air compressor. In applications where the GM Torqmatic Converter (see pages 309, 310, 311) is desired, it is designed specifically for the engine and installed as an integral unit at the factory. The General Motors hydraulic reverse and reduction gear is also available for Marine applications.

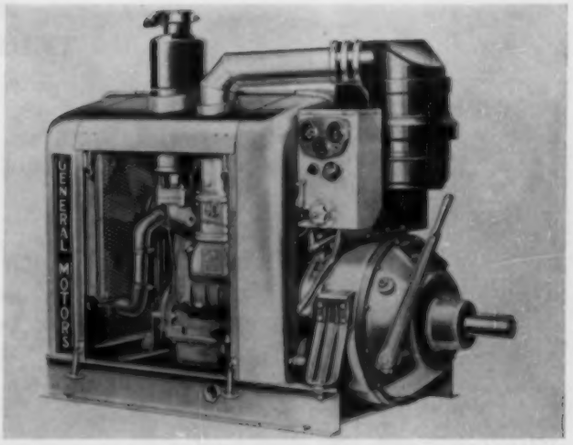
THE TWIN "6-110" WITH TORQMATIC CONVERTERS and chain compounded drive is a new "twin" class. Rated with mechanical power take-off, this unit produces 416 continuous horsepower at 1030 RPM and has an intermittent rating of 541 horsepower at 1145 RPM. Both engines on this multiple unit are provided with "dumping" type converters between the engine and the compound. This permits either engine to be disengaged from the load quickly without the use of clutches and gives the Twin "6-110" the same flexibility in power output and alternate engine operation as the "twin" or "quad" 6-71 models.

Compounding of the two engines in the new Twin "6-110" is accomplished with a "high velocity"



GM Detroit Diesel's four cylinder Series 51 marine engine.

Series 51 Industrial Power Unit.



chain drive instead of gears. This permits a wider range of reduction speeds and a lower output shaft speed. The chain, sprockets and bearings are completely pressure lubricated and the chain case of the compound serves as a sump tank for the torque-converter oil when dumped. The unit is also available without torque converters.

A single-fan radiator cools both engines of the Twin. Fan drive is by means of a multiple "V" belt drive; drive pulleys on both engines with high-capacity over-riding clutches keep the fan in operation when one engine is idling or shut down.

Altogether the new "6-110" Twin is an efficient, flexible, compact, portable, high-horsepower unit. It has an overall width that permits multiple unit coupling to now-existing rig compounding case centers without crowding.

A "6-110" TANDEM-TWIN UNIT providing 440 to 578 shaft horsepower at 1800 to 2000 RPM respectively is Detroit Diesel's latest development for heavy duty work boats or large pleasure craft. This unit consists of two "6-110" marine Diesels mounted end-to-end driving through a common gear box. A power take-off shaft may be attached to either end of the gear box depending on rotation requirements. The Tandem Twin "6-110" is also provided with General Motors hydraulically operated marine gears in 8 different speed reduction ratios up to 6:1.

GM DETROIT DIESEL SERIES 51 DIESEL ENGINES

THE SERIES 51 VALVELESS DIESEL represents a new degree of compactness in Diesel engine design and makes the use of Diesel Power practical for many more applications both in the industrial and marine fields.

The engine is available in four cylinder models with a displacement in each cylinder of approximately 54 cubic inches. It has the favorable design feature of being a "square" engine as both bore and stroke are 4.1 inches. Compression ratio is 18 to 1.

In this unit, Detroit Diesel engineers have achieved a loop-scavenged engine of extreme simplicity. Exhaust valves and valve operating mechanisms are eliminated through the use of both intake and exhaust ports in the cylinder liners. A Roots type blower similar to that used in Series 71 engines provides efficient scavenging at all speeds.

Other features include a pneumatic governor completely free of wearing parts and a rotor type lubricating oil pump built around and activated by the crankshaft.

The four-cylinder engine is available in fan-to-flywheel, power package and marine propulsion models. The flywheel on the marine unit is located at the front of the engine to provide better conformity with the hull. Marine models have heat exchanger cooling with only fresh water reaching the block, head and exhaust manifold.

The four-cylinder power package, complete as illustrated, weighs 1450 pounds and is rated at 76 BHP at 2500 RPM; the 4-51 marine engine with direct drive weighs 1300 pounds and delivers 87 SHP at 3000 RPM.

GENERAL MOTORS TWO CYCLE INDUSTRIAL DIESEL ENGINES

VEHICULAR, PORTABLE AND STATIONARY POWER PLANTS

Model	Continuous Horsepower 1800 RPM	Rated Horsepower (at 2000 RPM 70 Cu. MM. Injectors on "71s")	No. of Cylinders	Bore and Stroke	Fuel System	Weight	Starting	Length (inches)	Width (inches)	Height (inches)
4-51	54*	76**	4	4.1 x4.1	Injectors	1450	Electrical	57⅜	28	41¼
2-71	44	60	2	4¼x5	"	960	"	31	28 1/16	40½
3-71	67	89	3	4¼x5	"	1575	"	37¼	29½	40½
4-71	93	127	4	4¼x5	"	1750	"	42⅞	29½	41 1/16
6-71	142	195	6	4¼x5	"	2135	"	54 7/16	29½	42 1/16
Twin 4-71	182	248	8	4¼x5	"	4820	"	85	56	57 1/16
Twin 6-71	278	381	12	4¼x5	"	5620	"	94¼	56	57 1/16
Quad 6-71	556	762	24	4¼x5	"	12,425	"	181½	57 1/16	68⅝
6-110	210	274***	6	5 x5.6	"	2960	"	62⅝	37¼	49 7/16
Twin 6-110	416	541***	12	5 x5.6	"	11,400	"	125⅛	66	87⅛

* @ 2200 RPM ** @ 2500 RPM ***110 cu mm injector

See Turbopower Unit Ratings on Page 223

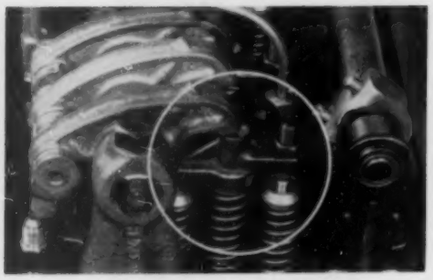
Multiple engine units include radiator, base and power take-off. Weights and dimensions approximate.

MARINE PROPULSION UNITS

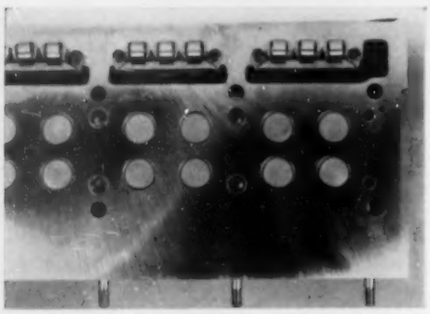
Model	Pleasure Craft 2100 RPM	Work Boats Continuous HP 1800 RPM	No. of Cylinders	Bore and Stroke	Fuel System	Complete Unit Weight	Starting	Length (inches)	Width (inches)	Height (inches)
4-51	87**	60*	4	4.1 x4.1	Injectors	1300	Electrical	48⅛	26¼	31
3-71	110x	68	3	4¼x5	"	1580	"	51¼	32 1/16	35 1/16
4-71	151x	95	4	4¼x5	"	1850	"	57½	32 1/16	35 1/16
4-71ø	151x		4	4¼x5	"	1920	"	58 1/16	38 1/16	32½
6-71	235x	147	6	4¼x5	"	2740	"	60⅝	36 1/16	40½
6-71ø	235x		6	4¼x5	"	2270	"	69 1/16	38 1/16	34¼
Twin 6-71	447	295	12	4¼x5	"	6400	"	74¾	59⅛	40⅝
Tandem Twin 6-71	447	295	12	4¼x5	"	7550	"	129	37¼	56⅛
Quad 6-71	893	590	24	4¼x5	"	12,850	"	128	56	58 1/16
6-110	289***	220	6	5 x5.6	"	4235	"	79⅛	39 1/16	45¼
Tandem Twin 6-110	578***	440	12	5 x5.6	"	10,800	"	145⅛	53 1/16	71⅛

* @ 2650 RPM ** @ 3000 RPM *** @ 2000 RPM ø Inclined engines x 2300 RPM

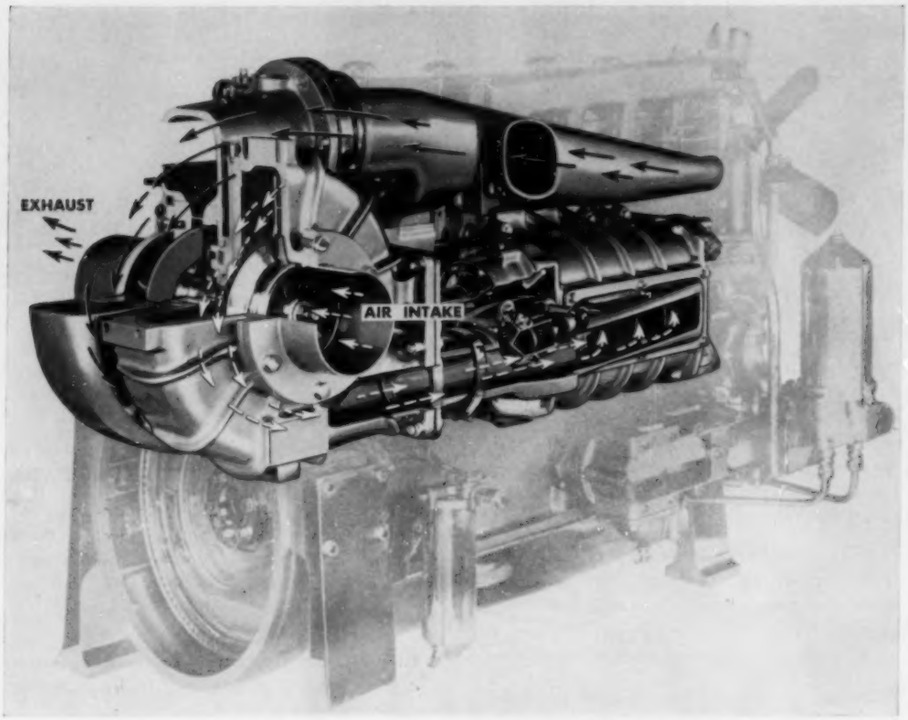
DETROIT DIESEL TURBOPOWER ENGINES



Rocker arm assembly on cylinder head of Turbopower engines which activates the four exhaust valves and the injector. End rocker arms each activate two valves by means of a bridge assembly (in circle) which connects to each valve. Center rocker arm operates the injector.

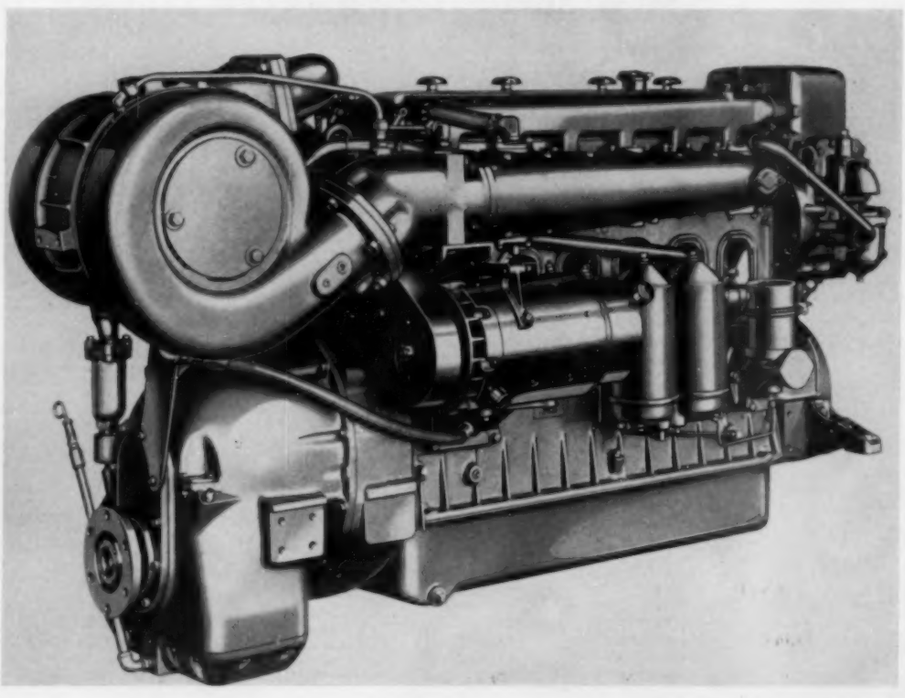


A section of the cylinder head fire deck showing the four exhaust valves per cylinder. Also shown are the directional water nozzles, the rollers on the bottom of the cam followers and in the center of each set of valves the injector tip opening.



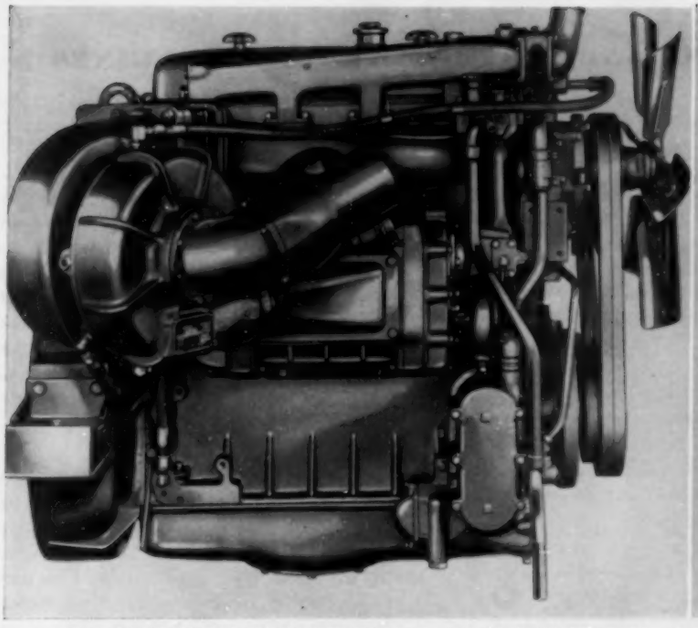
Cutaway view of the Detroit Diesel Turbopower engine showing path of exhaust gases through exhaust-driven turbine and resulting flow of fresh air from turbine-driven air impeller to the Roots blower.

Detroit Diesel 300 HP Turbopower marine unit. Models are available in right- or left-hand rotation units with either cast iron or aluminum block.

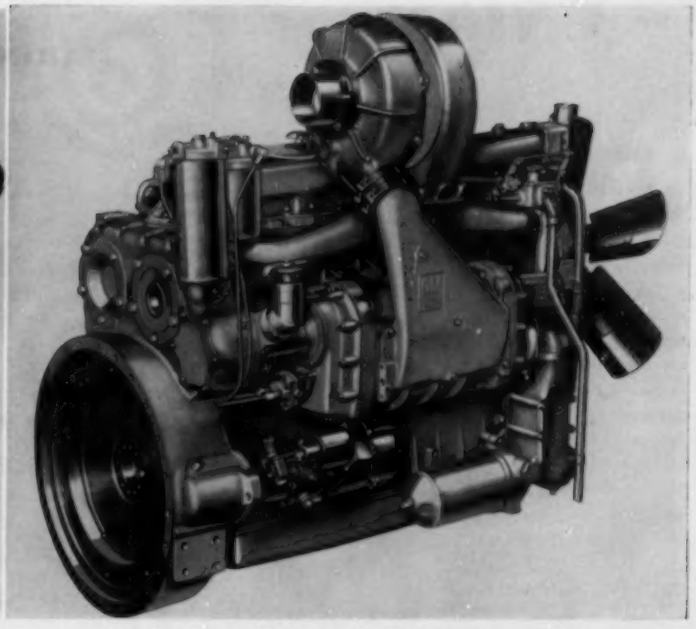


DETROIT DIESEL TURBOPOWER engines are presently offered in four and six-cylinder models for both industrial and marine applications. These engines are basic Series 71 units retaining General Motors' two-cycle design, the unit injector fuel system, uniflow blower scavenging and other Series 71 features described on previous pages. A single-shaft, exhaust-driven centrifugal turbine added to the already highly efficient Series 71 engine has produced a diesel of even greater fuel economy with an outstanding power-to-weight ratio.

The exhaust turbine teams up with the standard Roots blower to increase the scavenging air supply and the pressure at which the air is delivered to the air box. The turbine utilizes the "free push" of expanding exhaust gases rather than any power developed by the engine itself. The use of the turbine together with other design changes results in better air-to-fuel ratios, which in turn contribute to improved combustion and better all-around efficiency at all engine loads. The improved performance of Turbopower engines is achieved with no increase in fuel input and with no increase in weight-to-horsepower ratios.



The Detroit Diesel four-cylinder Turbopower unit for industrial use is rated at 171 basic horsepower. The unit may also be used as a replacement engine for on and off the highway trucks.



Detroit Diesel 236 HP fan-to-flywheel Turbopower engine for industrial use.

The turbine also contributes to the over-all efficiency of the engine in another way. Working in conjunction with the engine-driven blower, the turbine lightens the blower load and permits a reduction in blower speed. The resultant saving in horsepower is released for use at the shaft. The air-intake ports of Turbopower engines are of increased size and extend to a higher level on the cylinder liner. These changes take care of the increased air supply by permitting a larger charge of air to enter the cylinders and also by allowing the ports to remain open for longer air-intake periods.

A fast and complete elimination of exhaust gases in turbopower engines has been attained by increasing the number of exhaust valves in each cylinder from two to four. The valves are activated by rocker arms on the head as in Series 71 engines but each rocker arm activates two valves. This is accomplished by means of a bridge piloted on a shaft which is screwed into a tapped hole in the cylinder head. The bridge is adjusted to contact each valve equally. The valve lash adjustment is done as in non-turbopowered Series 71 engines.

The four-cylinder model is a fan-to-flywheel engine for industrial use. It has a rating of 171 basic horsepower at 2300 rpm. Its compact size and higher horsepower rating also make it ideal for use as a replacement engine for on and off the highway trucks.

The six-cylinder model is available for industrial use as a fan-to-flywheel engine and also as a base-mounted power unit. It is rated at 236 basic horsepower at 2100 rpm. For marine use Turbopower units are available in four and six-cylinder models. They are offered with cast iron or aluminum blocks in either right or left hand rotation. These engines are rated from 197 horsepower at 2300 rpm.

The four-cylinder Turbopower unit is also available for marine used as an inclined model.

The Turbopower units are highly efficient additions to the Detroit Diesel line providing a wider horsepower range. They do not replace any existing models.

VEHICULAR, PORTABLE AND STATIONARY POWER PLANTS

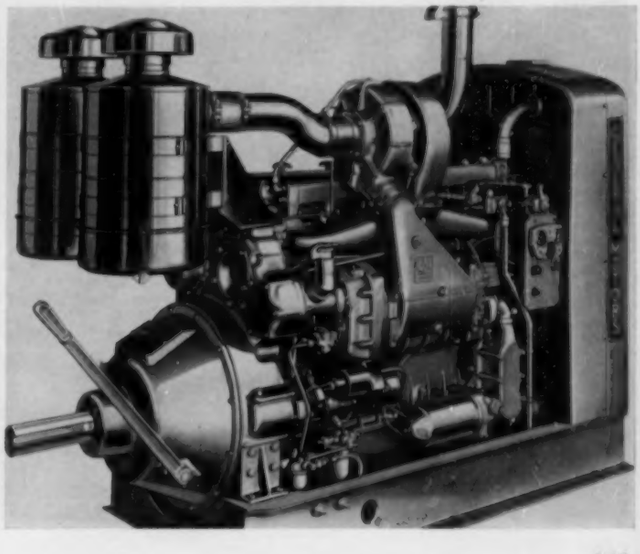
Model	Cont. HP 1800 RPM	Rated HP 2000 RPM	No. of Cyl.	Bore & Stroke	Fuel System	Weight	Starting	Length	Width	Height
4-71	94	138**	4	4¼x5	Injectors	1640	Elect.	43 11/16	36 13/16	40⅛
4-71T #	114	159**	4	4¼x5	Injector	1760	Elect.	43 11/16	45 5/16	40⅛
6-71	142	195	6	4¼x5	Injector	2135	Elect.	56	29 1/16	48 11/16
6-71T #	171	223*	6	4¼x5	Injector	2220	Elect.	55½	33⅛	47 1/16

MARINE PROPULSION UNITS

Model	Pleasure Craft Rated S-H-P 2300 RPM	Work Boats Cont. S-H-P 1800	No. of Cyl.	Bore and Stroke	Fuel System	Complete Unit Weight	Starting	Length	Width	Height
6-71	235	147	6	4¼x5	Injector	2740Ø	Elect.	68⅛Ø	36 1/16Ø	40¼Ø
6-71T #	300		6	4¼x5	Injector	3025##	Elect.	84¼	34⅛	43¼

Turbopower * 2100 RPM Ø Pleasure Craft
Aluminum Block 2555 lbs. ** 2300 RPM

The 6-71 base-mounted Turbopower unit has a basic rating of 236 HP at 2100 RPM.



UNION

MARINE AND STATIONARY DIESEL ENGINES

UNION Diesels are manufactured by The Union Diesel Engine Company in Oakland, California, U.S.A. This concern built the first commercially successful internal combustion engine which used liquid fuel. It has been active in the manufacture of heavy duty internal combustion engines continuously since 1885. Current models are available as shown in tables herein. For both marine and stationary services, engines are available naturally aspirated or supercharged. For stationary services they are available arranged as dual fuel engines or spark ignited gas engines as well as oil burning Diesel engines. All are intended for heavy duty service where dependability, long life and low maintenance costs are of prime importance.

Five basic bores and strokes are offered. These are arranged as six and eight cylinder engines. Fundamental designs are simple and functional. Conservative ratings are far below maximum power developing abilities. They are suitable for long lived, continuous operations.

GENERAL DESCRIPTION: UNION Diesel engines are of the four cycle, medium compression, mechanical injection, heavy duty type. Fuel ignition results from the heat of compression only. General design features include enclosed crankcase, individual cylinders, and forced lubrication. Designs are most flexible to permit customer-desired features to be incorporated readily and economically. The engine arrangement provides maximum accessibility for ease in maintenance and greatly facilitates servicing during operation.

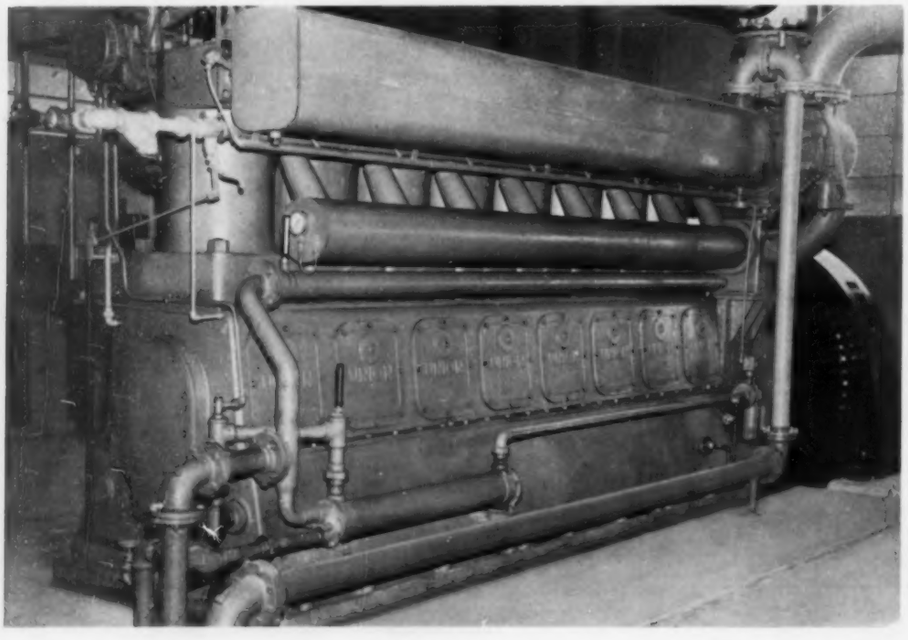
BEDPLATE is of cast iron, heavy girder construction with main bearings seated into integral cross members. It is oil tight. Marine bed forms a dry sump for lubricating oil; stationary beds are available with provisions for built-in sump of the wet type. Oil passages through cross members provide lubrication into each main bearing from its bottom half. Staybolts which secure cylinders to crankcase and bedplate are threaded into ample bosses adjacent to main bearings.

CRANKCASE is oil tight and forms a seating for the cylinders. It is secured to the bedplate at approximately crankshaft centerline. Large access doors are provided with built-in pressure relief valves in accordance with latest suggestions of classification societies.

MAIN BEARINGS are of the concentric, white metal lined type which are carefully grooved for proper, uniform lubrication. Each fits accurately into its bored seating in the bedplate. Linings are centrifugally cast into properly prepared shell. This results in heavy duty, long lived bearings, each of which may be readily removed. An extra bearing is provided at flywheel for greater reliability. Main bearing shells are accurately made to precision standards. This feature assures interchangeability and facilitates maintenance work.

CRANKSHAFT is machined all over from one piece steel forging which meets requirements of American Bureau of Shipping, British Corporation, Bureau Veritas and Lloyd's Register of Shipping. Webs and bearings are of ample dimensions. They are drilled for lubrication of crankpins and piston pins by the pressure lubricating system.

CONNECTING RODS are machined from steel forgings. They are of round section, accurately machined for uniform balance. This permits most careful check of materials. Axial hole is provided in each for passage of lubricating oil through piston and piston pin. Upper end forms piston pin bearing seating. Each lower end foot has secured to it both halves of steel crankpin bearing which is lined with centrifugally cast bearing metal. Bearings are accurately bored for dependable service. Crankpin bearing bolts are fitted and are of high tensile, alloy steel. Provisions are made for accurate adjustments of compression on each cylinder.



CYLINDERS are made from individual cast iron castings. Adequate inspection and clean out holes are provided. Alloy steel cylinder head studs are used. Inserted in each cylinder is a removable water contact type accurately bored, heat treated cast iron alloy cylinder liner. Design provides for ample cooling and permits re-boring, thus assuring longest life for least cost.

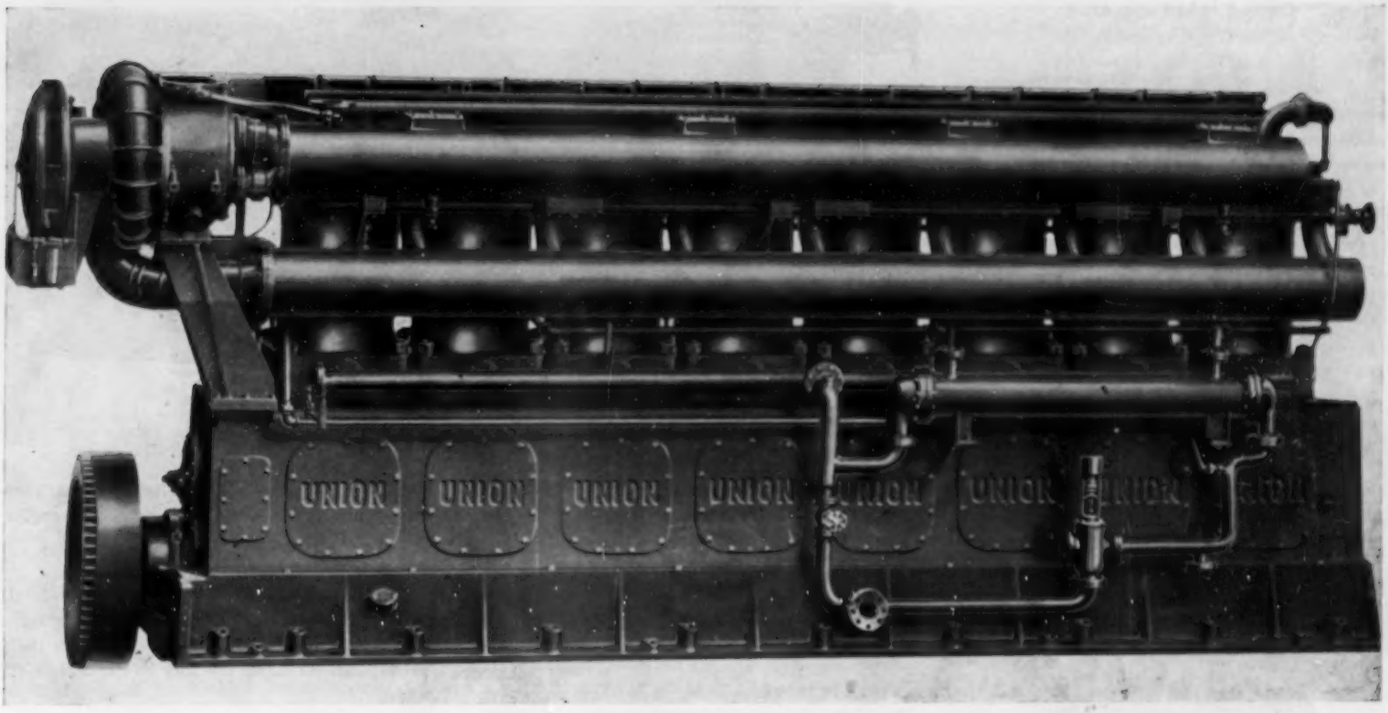
CYLINDER HEADS are of rugged design, carefully water jacketed. Special attention has been given to insure adequate cooling around all valves. Each cylinder head is fitted with a safety valve and a compression release valve to which an indicator may be connected. These quality features are in accordance with custom standards and are regularly provided on all heavy duty UNION diesels.

PISTONS are of cast iron heat treated and ground to close tolerances. The crown on each is provided with uniformly distributed metal which forms the combustion space. Adequate metal assures necessary heat flow without serious thermal stresses. Carefully engineered, adequate piston cooling of the "cocktail shaker" type is provided. Compression and oil control piston rings are of uniform tension. Each is of the "snap ring" design which may be readily removed and re-installed without being permanently distorted.

PISTON PINS are of case hardened steel accurately ground to fit the holes in piston pin bosses in which they "float." This construction eliminates the possibility of piston distortion. Piston pins are hollow and radial holes provide lubrication to bearing surfaces.

FLYWHEEL suitable for service intended is fitted to each UNION Diesel. Each is conscientiously designed, built of proper materials, accurately machined and carefully checked. Special assembly bolts secure each flywheel to its crankshaft. Fitted flange through-bolts of generous proportions rigidly secure together crankshaft, flywheel and driven shaft.

VALVES are of high heat resisting steel. Seats and guides are carefully water cooled. Ample proportions combined with quality materials properly heat treated assure maximum life with minimum attention. Valve stems are of large diameter. Their



bearing lengths are long. These features assure minimum wear through low unit bearing pressures, maximum cooling through large conductivity area and correct valve seating because of accurate alignment assured by the long valve stem bearings.

VALVE OPERATING GEAR used on UNION engines is an important feature found only in engines of highest quality. It incorporates overhead camshaft which is driven by a rugged gear-shaft train. Valves are operated by rocker arms actuated directly from camshaft through hardened steel cams and rollers. The precision steel camshaft of generous proportions is fitted into a splash-proof housing which is secured to the cylinders and is located alongside of the cylinder heads. Individual camshaft bearings are of the removable, precision type. Camshaft drive is from flywheel end of crankshaft between two main bearings. Pressure lubrication is automatic. It provides continuous lubrication to camshaft, bearings, rocker arm rollers and rocker arm fulcrum shafts.

GOVERNOR is also driven from flywheel end. This arrangement provides smoothest, most dependable governor drive. Wide ranges of governors are available to suit the particular requirements of each installation and to conform to the preferences of each owner. Simple, rugged mechanical governors are available where close speed regulations are not required but most readily maintained equipment is desired. Extremely accurate isochronous governors of the hydraulic type are provided when required for services needing such regulation.

LUBRICATING SYSTEM is of the force-pressure type. A positive displacement pressure pump forces lubricating oil to the crankshaft, connecting rods, pistons, camshaft, vertical shaft, governor, gears, piston pin bearings, and is of ample size for each service. On engines arranged with a dry sump, a similar pump removes the oil from the engine base to an exterior service tank. To keep the lubricating oil free from grit and other foreign substances, metal edge filters of ample area are provided and and so installed that they may be readily removed for cleaning. A separate turbocharger lubricating oil system is provided for all engines fitted with exhaust gas turbochargers.

UNION Diesel's own lubricating oil coolers of the tube-and-shell type are standard equipment. Each is properly engineered and installed to assure maintenance of correct lubricating oil temperature. Other lubricating oil coolers are available to suit customer's requirements.

COOLING SYSTEM is offered on each UNION diesel designed to suit the particular requirements of the installation. High temperature cooling may be used; fresh water cooling is frequently provided; salt water cooling is available. Pumps of various types are available, including centrifugal, both one way and reversible, and positive displacement piston pumps if desired. Engine mounted centrifugal cooling water pumps are gear driven directly from flywheel end of crankshaft. This UNION Diesel feature assures most dependable, quiet, long lived service. Motor driven pumps may also be used. UNION tube-and-shell heat exchangers are frequently used because they are designed and built for the particular requirements of heavy duty internal combustion engine cooling. However, each cooling system is specifically engineered to meet the conditions of each installation.

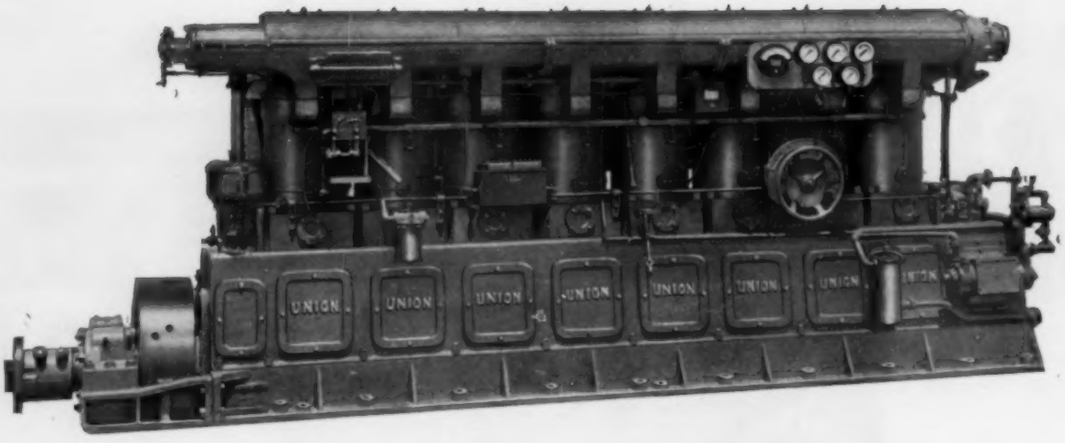
STARTING SYSTEM is of the pneumatic type. Starting air of 150-300 lbs./sq.in. is used. Starting air valves are in removable cages with one in each cylinder head. These valves are of the pneumatic, balanced type. They are actuated by pilot air regulated through special, self-maintaining piston units. One special cam on camshaft controls pilot timing for all cylinders.

FUEL SYSTEMS are available to suit the requirements of each installation. The exclusive UNION Fuel System of the automatically controlled pressure type with mechanically operated fuel injection valves located in the center of each cylinder head is normally provided. Individual jerk pumps are available and used on certain types of installation. On either fuel system, fuel oil is sprayed through multi-jet orifices into combustion spaces. Each fuel injection valve is capable of being positively and accurately adjusted. Each spray nozzle tip may be changed without disturbing the needle valve on its seat. Each tool steel needle valve seat is readily replaceable. Fuel pumps in their blocks are accessible, replaceable, and interchangeable by assembly. All plungers are of the "packless" type.

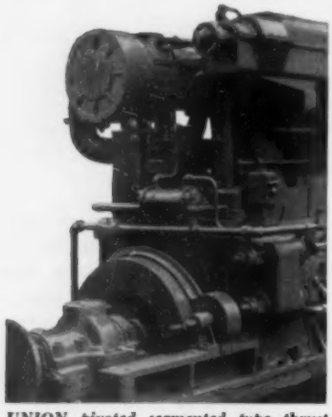
SUPERCHARGING of UNION Diesels by exhaust gas driven turbochargers has been done since 1937. Various methods of supercharging are available to suit individual requirements.

ALARM SYSTEMS: UNION Diesel designed alarm and safety devices are adaptable to most engine room requirements; they will reduce the size of crew required for safe and satisfactory operation.

UNION MARINE DIESELS are specially designed and constructed to the highest maritime standards. The built-in ruggedness and superior craftsmanship assures continuous efficient and economical service with a minimum of maintenance. Simplicity of control and ease of operation are features of interest to owners and engineers. Greatest availability of parts and assemblies is provided. Running conditions can be more thoroughly checked during operation. UNION Diesel's exclusive designs facilitate inspection, maintenance and repairs.



RECORD—Since 1923, Union Marine Diesels have powered boats for many types of service and in all climates. They are the source of propulsion for tugs in busy metropolitan harbors, for patrol boats in the Arctic, and for freighters and tankers in the tropics. A large majority of the UNION diesels sold are in daily service, regardless of age.



UNION pivoted segmented type thrust bearings are standard equipment on UNION Marine Diesels. Turbocharged Diesels are available to suit individual requirements

TOWBOATS and TUGS, both large and small, get more tow line pull per rated horsepower from slow speed, heavy duty UNION Marine Diesels.

TUNA CLIPPERS—ever since their inception, have relied upon rugged UNION diesels for main propulsion and auxiliary power.

FISHING VESSELS including New England trawlers, Atlantic draggers, Pacific Coast purse seiners, Arctic halibut schooners and tropical bait boats have for long been powered with UNION engines. Owners continue to select UNION Diesels for long lived operation.

TANKERS—and trading schooner operators prefer the simplicity of UNION Marine Diesels.

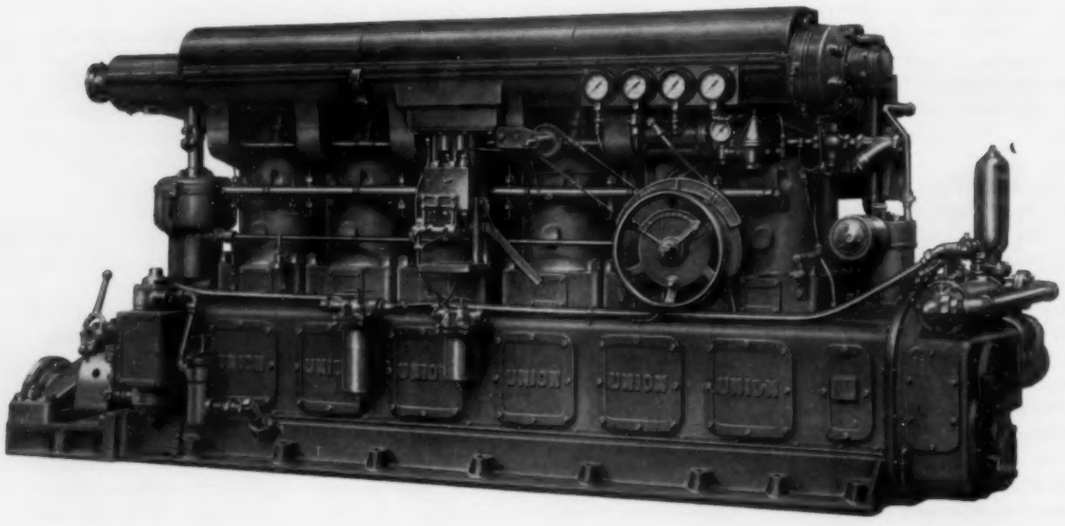
FERRY BOATS—From British Columbia to Texas depend on UNION Marine Diesels to maintain schedules. UNION Diesel's Double Ended and Direct Reversing Marine engines are exceptionally desirable for the main propulsion in ferry boats. They are available in all sizes with remote or engine room control.

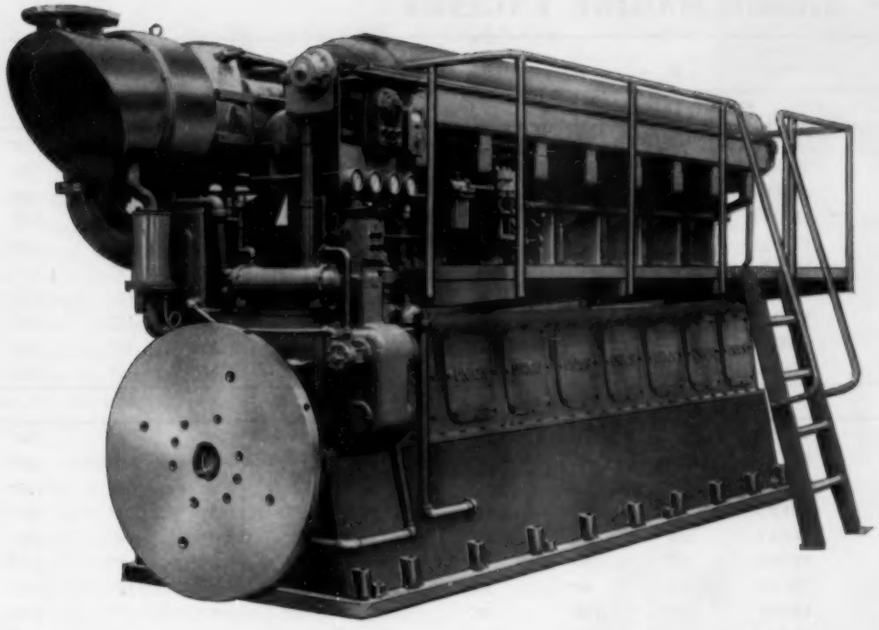
PATROL BOATS—The Armed Forces, Federal, State and Foreign Government law enforcing agencies depend on UNION Marine Diesels in their patrol boats for round-the-clock service and in all weather.

Some of the UNION Marine Diesel features are:

REVERSING SYSTEM: These reversible engines are of the sliding camshaft type with hardened steel, ahead and astern cams. The maneuvering mechanism is pneumatically powered and manually operated from engine control station. Wheelhouse engine controls are available when desired. UNION Diesel's exclusive Dynamic Braking may be incorporated whenever exceptionally severe maneuvering conditions are to be encountered.

THRUST BEARINGS on UNION Marine Diesels are carefully engineered to meet the requirements of the vessel. UNION pivoted segmental type thrust bearings are supplied on all engines where installational requirements permit.





BASIC DESIGN of UNION Diesel Engines makes it practical to offer the UNION Stationary Diesel as a source of reliable and economical power for applications demanding continuous, heavy duty service. The design lends itself to custom built equipment and engineered accessories to suit the particular needs of unusual power requirements. The best of materials and workmanship are employed in their construction. Modern production techniques permit these engines to be offered competitively for usual power requirements.

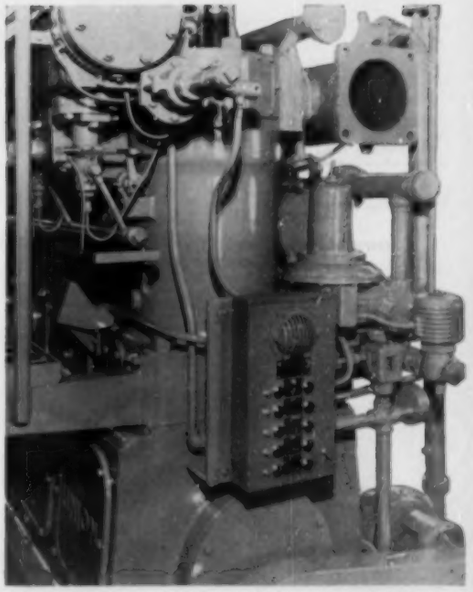
MILLS AND MINES throughout the world rely on UNION Diesels as a direct source of power to turn electric generators and drive pumps under varying conditions.

ELECTRIC POWER PLANTS both large and small find UNION Stationary Diesels well suited as prime mover where economical and unfailing power is essential. UNION Diesel generating sets are available from 100 KW to 1250 KW. UNION Diesels efficient governors drive at the flywheel end of the engine. Hydraulic isochronous governors are features that assure accurate speed control.

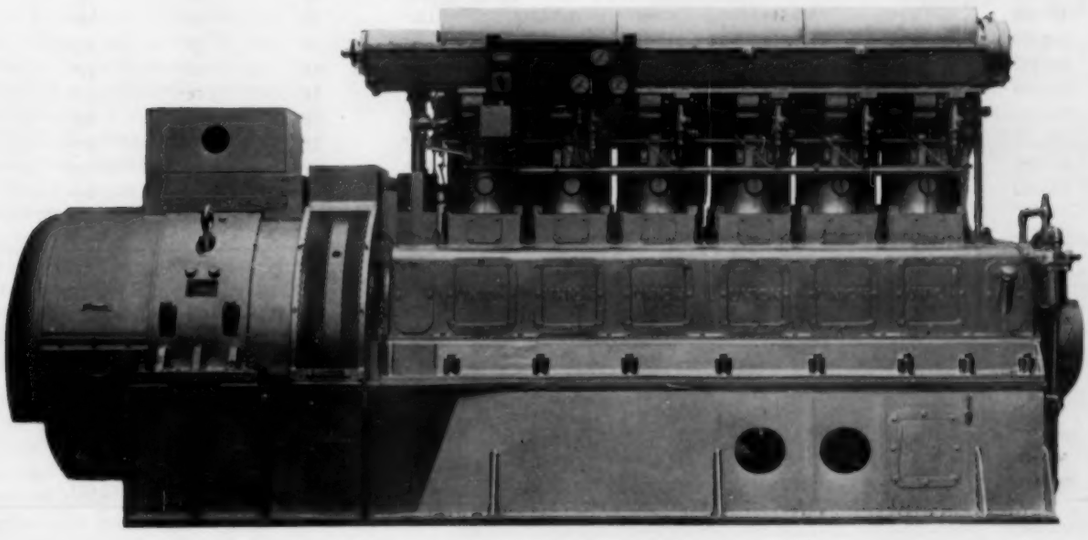
BEDPLATE or ENGINE BASE on the stationary model is available in two designs; the conventional dry sump or a sump of the wet type. Structural steel sub-base for mounting the engine and driven equipment as a unit is also available, engineered to suit individual installations.

DUAL FUEL system on UNION Diesels is efficient and economical. The design of each UNION Diesel dual fuel engine is based upon requirements of each installation. Dual fuel engines are available in all sizes. Gas is accurately metered and controlled to each cylinder independently, as is fuel oil. Regulation of quantities of fuels, rates of injection and timing permit excellent performance with desirable economies to be attained without resorting to high temperatures or pressures.

SPARK-IGNITED gas engines are custom built for continuous service and designed for individual installations. UNION Diesels standardized components are used whenever applicable for best availability and most economical price.



UNION Diesel Dual Fuel engine showing individual fuel injection pumps, automatic shut down device, gas control valve, gas pressure regulator, and UNION alarm panel.

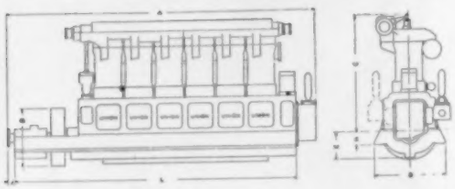


UNION DIESEL MARINE ENGINES

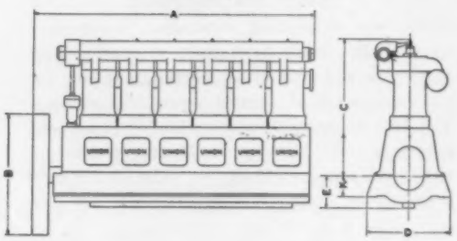
H.P.	Bore and Stroke	R.P.M.	Approx. Net Wt.	Code Word	A	B	C	D	E	J	K	L
SIX CYLINDER												
175-225	8½" x 11"	475-600	14,000	CODRE	144"	28"	55"	34"	13"	9"	6"	123"
240-350*	8½" x 11"	475-600	15,000	YEERP	146"	28"	55"	34"	13"	9"	6"	125"
230-335	10" x 14"	350-500	23,500	CORYS	175"	36"	68"	42"	17"	5"	8"	158"
320-500*	10" x 14"	350-500	24,500	YEEWT	178"	36"	68"	42"	17"	5"	8"	161"
410-515	12" x 15"	400-500	36,500	COVAJ	194"	36"	74"	46"	19"	6"	8"	176"
565-775*	12" x 15"	400-500	38,000	YEFCE	194"	36"	74"	46"	19"	6"	8"	176"
500-700	14" x 19"	300-400	58,000	COSON	242"	46"	92"	57"	22"	6"	11"	216"
750-1060*	14" x 19"	300-400	60,000	YEFHY	242"	46"	92"	57"	22"	6"	11"	216"
600-900	16" x 20½"	240-360	87,500	COSUX	275"	52"	101"	62"	24"	6"	15"	249"
850-1350*	16" x 20½"	240-360	90,000	YEGAC	285"	52"	101"	62"	24"	6"	15"	252"
EIGHT CYLINDER												
235-300	8½" x 11"	475-600	18,000	YEAXT	178"	28"	55"	34"	13"	9"	6"	158"
320-460*	8½" x 11"	475-600	19,000	YEEVS	180"	28"	55"	34"	13"	9"	6"	160"
310-445	10" x 14"	350-500	32,000	YEBUC	214"	36"	68"	42"	17"	5"	8"	195"
425-665*	10" x 14"	350-500	33,500	YEFAB	217"	36"	68"	42"	17"	5"	8"	198"
550-700	12" x 15"	400-500	46,000	YECAY	235"	36"	74"	46"	19"	6"	8"	217"
750-1040*	12" x 15"	400-500	48,000	YEFFO	239"	36"	74"	46"	19"	6"	8"	221"
670-935	14" x 19"	300-400	74,000	YECEZ	296"	46"	92"	57"	22"	6"	11"	270"
1000-1400*	14" x 19"	300-400	76,000	YEFID	299"	46"	92"	57"	22"	6"	11"	270"
800-1200	16" x 20½"	240-360	112,000	YEDAZ	344"	46"	101"	62"	24"	6"	15"	310"
1135-1800	16" x 20½"	240-360	115,000	YEGCA	347"	46"	101"	62"	24"	6"	15"	313"

*Supercharged

General Dimensions—UNION Direct Reversible Marine Diesel Engines



General Dimensions—UNION Stationery Diesel Engines



UNION DIESEL STATIONARY ENGINES

H.P.	K.W.‡	Bore and Stroke	R.P.M.	Approx. Net Wt.	Code Word	A	B	C	D	E	K
SIX CYLINDER											
150-240	100-150	8½" x 11"	450-600	12,500	WYBBA	114"	40"	55"	34"	13"	6"
225-330*	150-200	8½" x 11"	450-600	13,500	WYBCE	117"	40"	55"	34"	13"	6"
225-320	150-200	10" x 14"	360-514	20,000	WYBOF	135"	50"	68"	42"	17"	8"
300-530*	200-350	10" x 14"	360-514	21,000	WYBUG	135"	50"	68"	42"	17"	8"
380-575	250-350	12" x 15"	400-514	34,500	WUYVY	162"	54"	74"	47"	19"	8"
525-800*	350-500	12" x 15"	400-514	36,000	WYIBD	166"	54"	74"	47"	19"	8"
450-750	300-500	14" x 19"	300-400	53,000	WYEMN	185"	72"	92"	57"	22"	11"
750-1100*	500-700	14" x 19"	300-400	54,500	WYENP	185"	72"	92"	57"	22"	11"
600-925	400-600	16" x 20½"	240-360	80,000	WYGHE	203"	84"	101"	62"	24"	15"
750-1400*	500-900	16" x 20½"	240-360	82,000	WYGIJ	203"	84"	101"	62"	24"	15"
EIGHT CYLINDER											
200-310	125-200	8½" x 11"	450-600	16,000	WYHHA	144"	40"	55"	34"	13"	6"
300-450*	200-300	8½" x 11"	450-600	17,000	WYHIB	151"	40"	55"	34"	13"	6"
265-420	175-250	10" x 14"	360-514	26,000	WYHJE	171"	50"	68"	42"	17"	8"
400-700*	250-400	10" x 14"	360-514	26,500	WYHLO	171"	50"	68"	42"	17"	8"
450-750	300-500	12" x 15"	400-514	45,000	WUZUV	198"	54"	74"	47"	19"	8"
750-1100*	500-750	12" x 15"	400-514	46,500	WYIJL	202"	54"	74"	47"	19"	8"
600-1000	400-600	14" x 19"	300-400	70,000	WYKON	234"	72"	92"	57"	22"	11"
900-1400*	600-900	14" x 19"	300-400	72,000	WYLAL	234"	72"	92"	57"	22"	11"
750-1250	500-800	16" x 20½"	240-360	98,000	WYOPS	259"	84"	101"	62"	24"	15"
1050-1875*	700-1250	16" x 20½"	240-360	100,000	WYORV	259"	84"	101"	62"	24"	15"

*Supercharged ‡Standard Generators

P & H DIESEL ENGINES

HARNISCHFEGER

THESE P & H Diesel engines have been especially developed and refined for the tough service of industrial and marine applications. Of rugged design, they pack power into small space and weight, yet are easily serviced. Built on the two-cycle principal, the outstanding feature is the patented, fully water jacketed individual P & H cylinder head and liner assembly unit which is readily removed and replaced when maintenance work is required.

The patented P & H cylinder head and liner assembly is the heart of the P & H diesel engine. Each cylinder has an independent power assembly unit which provides a great saving in time on any maintenance work and reduces the cost of major overhauls. The Model C-18 cylinder head and liner assembly enables complete dismantling in the field. Liner air inlet ports are specially machined on a compound angle to send air into cylinder with a strong swirling motion—providing thorough scavenging of exhaust gases and complete combustion on next stroke. The entire assembly is completely water jacketed and thoroughly cooled.

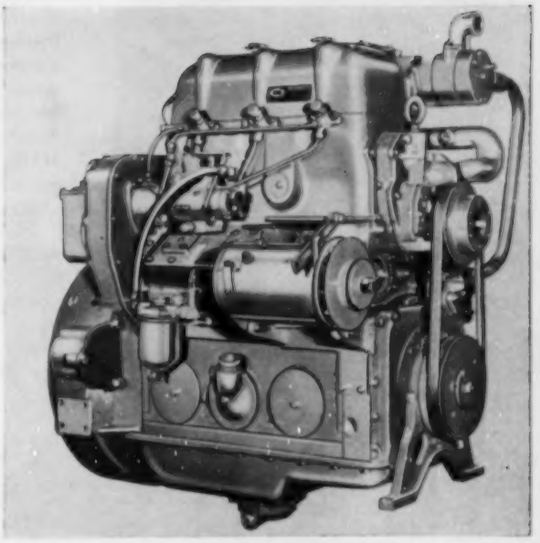
P & H Diesel engines have a bore and stroke of 4½ by 5½ inches, and piston displacement of 174, 261, 348, and 522 cubic inches, in two, three, four, and six cylinder sizes respectively. The construction of these engines can be seen from the illustrations shown here.

CRANKCASE AND CYLINDER BLOCK are in one piece of high strength aluminum alloy. Heavy ribs and columns insure rigidity and permanent alignment of all parts. The individual cylinder head and liner assemblies are inserted into the block from the top. Large inspection ports along each side opposite each cylinder give full access to the crankpin and main bearings. Crankshaft main bearings are carried in the lower cross members of this crankcase casting. The oil pan is bolted to the lower flanges.

CYLINDER HEAD AND LINER ASSEMBLY has an alloy cast iron liner with two rows of air inlet ports drilled around the lower circumference, each row of ports being drilled at different angles and especially designed to introduce air to the cylinders with a high degree of turbulence to effect thorough scavenging and complete combustion. The alloy cast iron head is threaded to the top of the liner for ease of replacement of either component in the field. The head carries the single exhaust valve in the center and the fuel injector port at an angle on one side. Corrosion resistant water jackets surround the cylinder liner to provide maximum cooling for the full length of the liner and carry the cooling water to the cylinder head water passages.

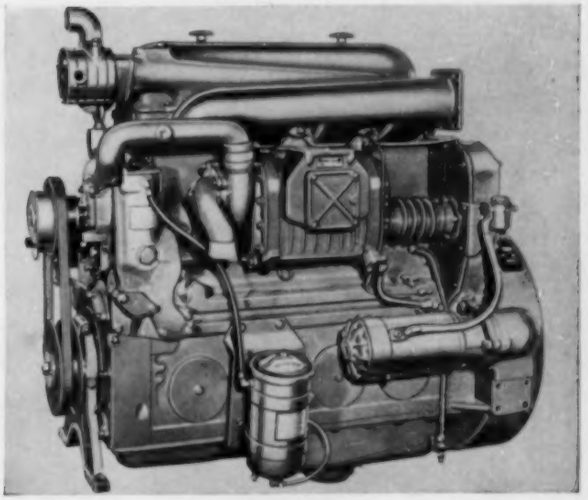
To replace a cylinder head and liner assembly, the procedure is to (1) disconnect injector fuel line and remove injector, (2) remove connecting rod cap through crankcase hand-hole doors (3) disassemble and remove rocker arm shaft and support assemblies, remove four head nuts and lift out

Harnischfeger P. & H.—Three cylinder Diesel showing Roosa fuel system.

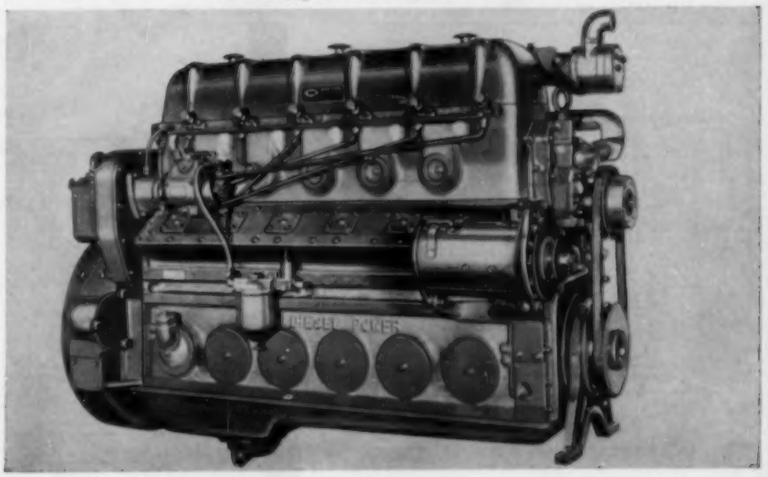


Liner, with replaceable jacket, head, piston and connecting rod. This assembly, minus rod cap, can be removed from engine in 40 minutes.

Harnischfeger P. & H. 4 cylinder diesel unit.



Harnischfeger P. & H. 6 cylinder diesel unit.



Model 687C-18 125 kw generator set with standard control panel. Also marine models.

cylinder head and liner assembly as a unit, including the piston and connecting rod assembly, (4) install replacement assembly units by reversing the action taken by these three steps.

CRANKSHAFT is forged alloy steel, heat treated, with pins and journals hardened against wear, and ground and polished and drilled for continuous lubrication. Shaft is statically and dynamically balanced to eliminate vibration. Main journals are 4 inches in diameter and crankpins are 3 inches, ample diameters to assure minimum bearing loading and long bearing life.

MAIN AND CRANKSHAFT BEARINGS are replaceable precision type steel backed aluminum tin alloy.

PISTONS are high strength aluminum alloy castings with four rings and two oil control rings. Piston pins are alloy steel, hardened and precision ground and lapped.

EXHAUST VALVE is Stellite faced, one per cylinder, water cooled, seats directly against insert in head, and is operated from the camshaft by a push rod and rocker arm assembly. The camshaft is special alloy steel, forged and heat-treated. Cams are integral with shaft, hardened and precision ground. Camshaft bearings are of aluminum alloy. Camshaft is located in a pocket on right side of crankcase and is driven by precision machined spur-toothed timing gears of high alloy steel, drop forged and heat-treated.

FLYWHEEL is of alloy cast iron, statically and dynamically balanced, and made to take various makes of clutches for the power take-off. Flywheel housing is demountable, of pedestal or arm type mounting, machined for S.A.E. standard No. 1 size.

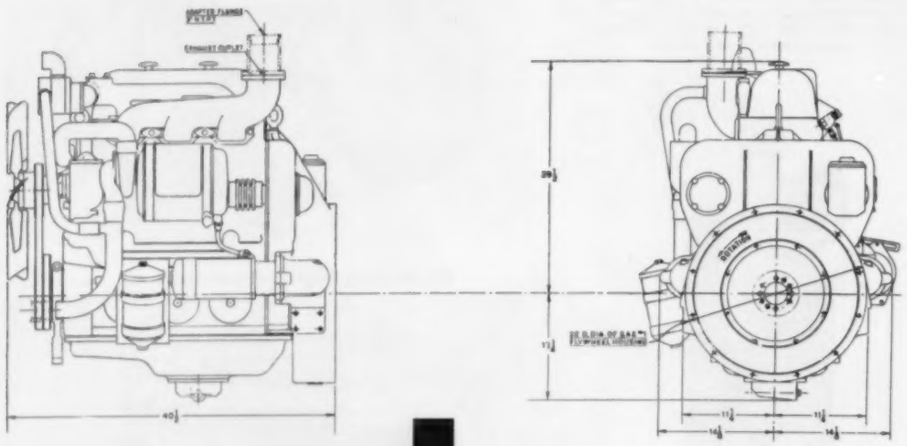
BLOWER is a gear driven positive displacement Roots type. The 2, 3, and 4 cylinder models each require one blower, while on the 6 cylinder model, two blowers mounted in tandem are required. Blowers are mounted on the left side of the crankcase and are gear driven from the gear train.

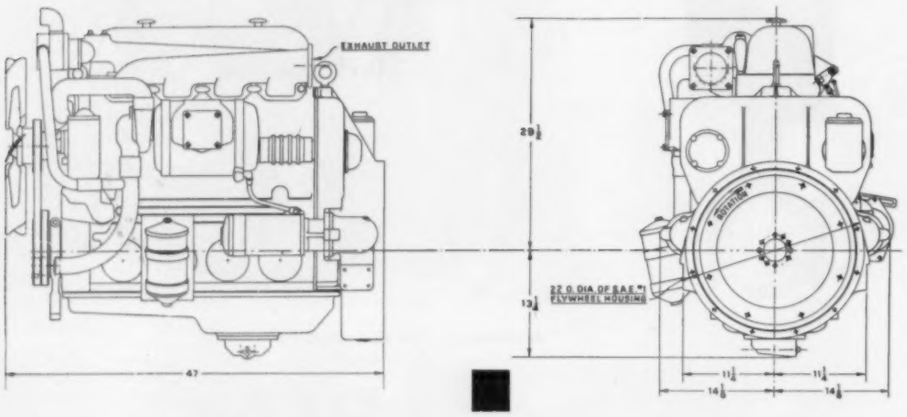
FUEL INJECTION is performed through a Roosa Master, single cylinder, opposed plunger, inlet metering, distributor type fuel pump. Built in accessories including governor, transfer pump, automatic timing advance, and pressure regulating piston together with the pump itself are enclosed in a pressurized oil tight compartment, thus preventing entrance of dust, water, or any foreign matter. The entire unit is self lubricating and pump calibration is inherent in construction. Fuel filter is mounted on the side of the engine and is easily accessible for cleaning and draining off water. Fuel injectors are pressure operated and have single large spray holes, thus decreasing the possibility of clogging. The latest fuel system incorporated in P&H Diesel engines combines simplicity of design with the highest degree of efficiency.

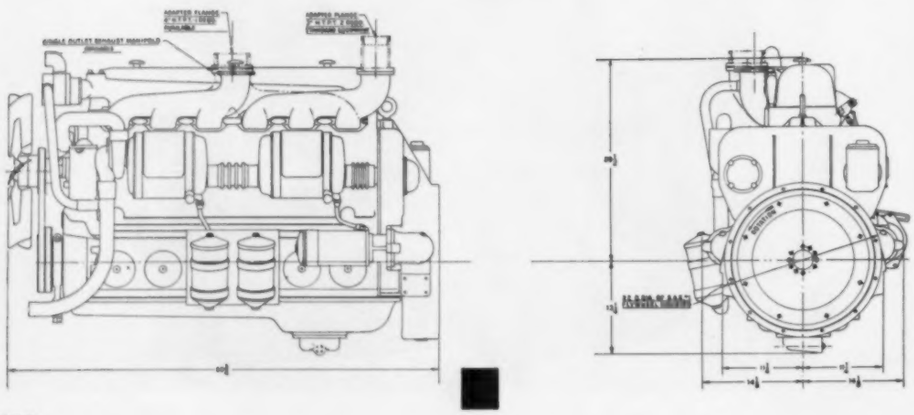
LUBRICATION is by pressure feed to all bearings and parts needing oil. Gear type oil pump is mounted on bottom of crankcase at rear end and is driven by a drive gear on the crankshaft. Oil pressure is regulated by a spring loaded piston valve located in the pump housing. Oil filter is located on side of crankcase easily accessible for cleaning and changing of filter elements.

COOLING SYSTEM includes radiator and fan, belt driven from the crankshaft. Circulating pump is of centrifugal type, mounted at front end of blower and driven by the blower upper rotor shaft. Thermostatic valve and by-pass shorten warm-up time and maintain proper operating temperatures.

STARTING is by 12 or 24 volt electric motor, flange mounted. Generator of similar voltage is base mounted and V-belt driven. A liquid primer type starting aid provides quick starting the year around whatever the temperature.







COMPLETE ENGINE LINE

The latest additions to the P&H Diesel line are the 2, 3, 4 and 6 cylinder automotive models ranging in horsepower from 40 to 280. The 2 and 3 cylinder models are becoming popular in medium truck, tractor and bus applications—the 4 cylinder in heavier trucks and buses. The 6 cylinder unit is designed for heavy trucks, tractors and off-the-highway equipment. The same low weight per horsepower present in other P&H models also characterizes these automotive models. This, of course, means greater pulling power for bigger payloads. When an overhaul becomes imminent, the characteristics of the engine are such that but a minimum of time and effort are required for complete rebuilding. The main controlling factor here is the P&H patented head and liner assembly.

The P&H diesels are proving to be equally popular for marine applications. The Model 487C-18 four-cylinder, two-cycle unit illustrated has a bore of 4½ in. and a stroke of 5½ in., a total displacement of 348 cu. in. and a compression ratio of 17.1. This engine has a horsepower rating of 144 @ 1800 rpm. and a maximum torque of 600 ft. lbs. SAE #1 flywheel housing is standard. Crankshaft has five main bearings, 4 inches in diameter Crankpin diameter is 3 in. The weight of the four cylinder marine engine complete is 2600 lbs dry. This marine unit is also manufactured in two, three and six cylinder models.

The P & H diesel engine is also produced in two, three, four, and six cylinder power units. These power units are finding ready application in the oil fields, in construction equipment, in the lumber industry, in quarries, in mines of all types and in quite a number of applications on the railroads.

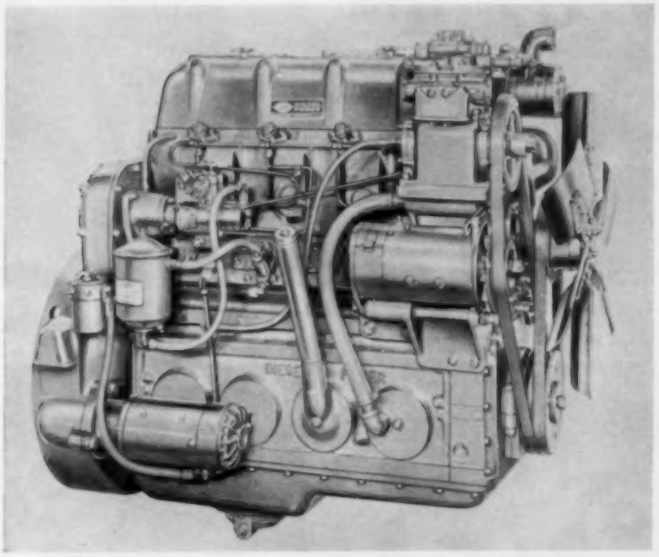
The complete P & H line of Diesel Generator Sets is designed for dependable continuous duty as well as standby emergency electric power.

Compact design and light weight enables easier transporting and requires less installation space.

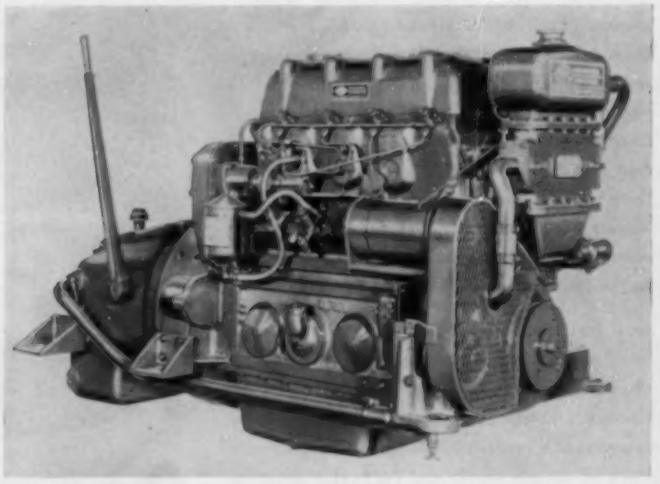
They are built in open and closed styles, with capacities from 20 to 125 KW, AC or DC, both industrial and marine types.

The complete control board is designed for parallel operation with a choice of controls: emergency or semi-emergency automatic, electric starting with push button or remote control.

P & H Model C-18 Enclosed Power Unit Having Standard Skid Base



P & H Model 487C-18A automotive engine complete with accessories



P & H Model C-18 marine engine having heat exchanger type cooling and mechanical reverse gear.

P&H DIESEL ENGINE—INDUSTRIAL, MARINE, AND AUTOMOTIVE
MODEL C-18 SERIES ENGINES

Model	Cycle	No. Cyl.	Bore & Stroke	Continuous BHP RPM	Intermittent BHP at RPM	Maximum BHP RPM	Intermittent Torque at RPM	Weight Lbs.	Dimensions HxWxL (inches)
287C-18	2	2	4½x5½	58 at 1800	67 at 1800	90 at 1800	235 at 1400	1090	42x29x32
387C-18	2	3	4½x5½	90 at 1800	103 at 1800	144 at 1800	336 at 1300	1290	42x29x40
487C-18	2	4	4½x5½	126 at 1800	144 at 1800	201 at 1800	482 at 1350	1588	42x29x45⅜
687C-18	2	6	4½x5½	180 at 1800	205 at 1800	280 at 1800	658 at 1300	1930	42x29x60

FAIRBANKS-MORSE

STATIONARY
Diesel
Dual Fuel
Spark Ignition Gas
Tri-Fuel

MARINE
Direct Drive
Direct Reverse
Reverse-Reduction Gear Drive

DUAL FUEL ENGINES

THE Fairbanks-Morse line of dual-fuel engines includes the 8½ by 11½ inch and 18 by 27 inch Model 31 engines, the 16 by 20 inch Model 33 engines, and the 5¼ by 7¼ and 8⅛ by 10 Model 38 engines. The dual fuel model designations are respectively 31AD8½, 31AD18, 33FD16, 38FD5¼, and 38DD8⅛. All of these models are of the two-cycle type and ignition is produced by a small injection of pilot fuel.

All Fairbanks-Morse dual fuel engines, except the Model 38FD5¼, Model 38DD8⅛ and Model 31-AD8½, are equipped with separate pilot fuel pumps designed especially to handle small quantities of pilot fuel oil required for this operation. The pilot fuel pumps are governor controlled so that the time of ignition varies with the load. This feature provides smoother operation and improves economy at lighter loads.

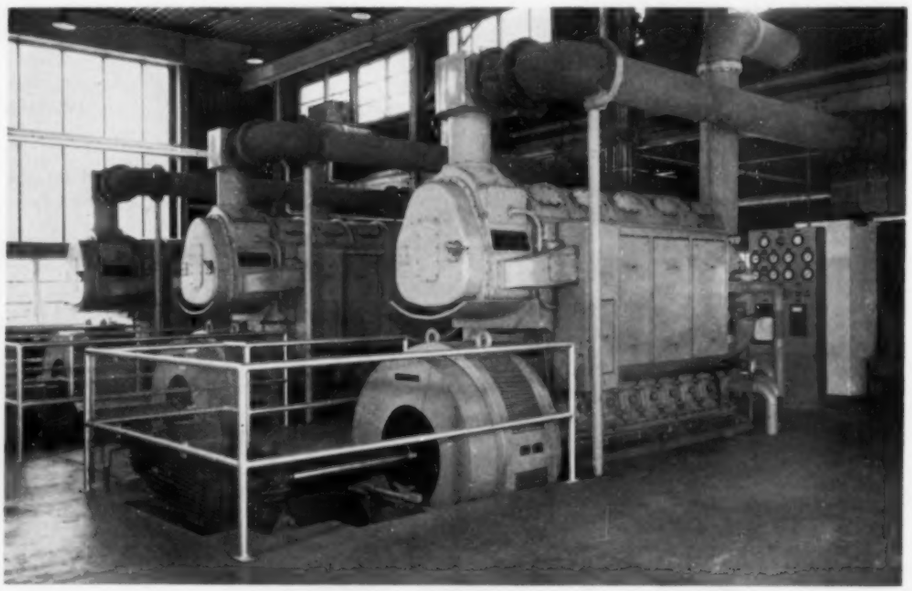
The Model 31AD8½ pilot fuel pump is incorporated in the regular injection pump, is not governor controlled, and therefore, the ignition timing is constant. On all the 16 by 20 and the 18 by 27 engines, the upper camshaft is mounted in an enclosed housing located on top of the air intake manifold and is automatically lubricated. It is chain driven from a sprocket mounted on the end of the regular camshaft. This upper camshaft drives the pilot oil pumps and actuates the gas valves, mounted in the cylinder heads.

Dual fuel engines have been designed for the utmost in safe operation. When operating on gas, the governor controls the pressure in the header through a throttle valve. If the gas supply pressure decreases to a predetermined point, a control valve shuts off the gas supply and the engine automatically reverts to full diesel fuel operation. When the gas pressure returns the controls must be manually reset to change back to gas operation.

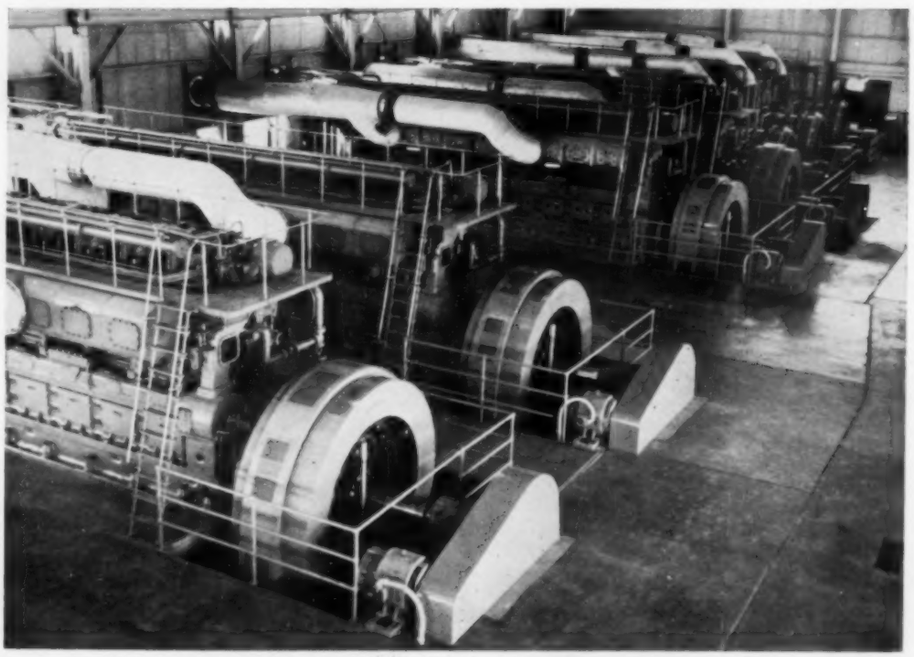
The engine cannot be started on gas because a control valve shuts off the gas supply until the engine has been started on diesel fuel and both lubricating oil and fuel oil pressure have been built up. Conversion from diesel fuel to gas fuel operation is simply accomplished by opening the main gas valve. Transition from gas to oil fuel and back again can be made under any load conditions.

In case of failure of pilot fuel oil, an automatic shutdown device has been installed to shut off the gas supply. It is important that the gas supply be shut off in case of loss of ignition in order to prevent the possible accumulation of raw gas in the exhaust system.

During part load operation when only smaller charges of fuel are burned, the air charges can also be reduced. Less air is then needed to support the combustion. Pumping of smaller quantities of air requires less horsepower. So, on the Fairbanks-Morse dual fuel engines, a bypass valve on the scavenging pump reduces the air-pumping horsepower and improves the fuel consumption at part load.



Three 6-cylinder, Model 38DD8⅛ dual fuel generating sets in city power plant.



Four 10-cylinder Model 31AD18 dual fuel engines direct connected to Fairbanks-Morse alternators.

SPARK-IGNITION ENGINES

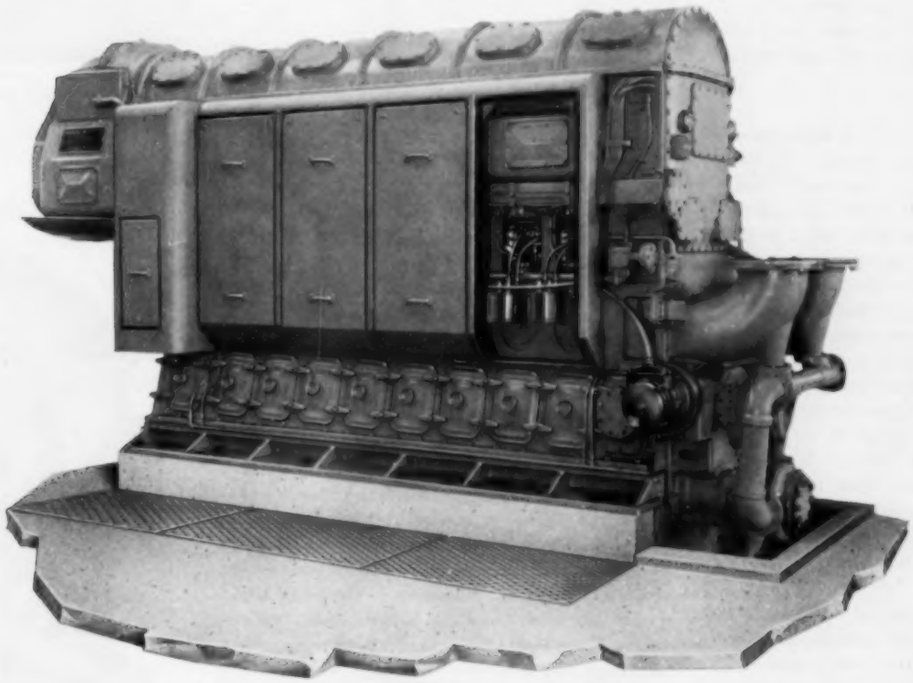
The Model 38 Opposed Piston Engine is now available as a high compression spark ignition gas engine, either by conversion of oil diesel or dual fuel engines in the field or on order at the factory as a new unit. The spark ignition modification employs the same high compression ratio as the diesel or dual fuel units, providing quick easy starting, and a uniformness of torque, horsepower and speed, with the excellent governor control typical of the two cycle principle. Gas admission to the cylinders is by the same arrangement as used on the dual fuel modification.

The spark ignition system eliminates completely such troublesome parts as breaker points, timing devices, distributors, and current interrupting devices. Instead, it furnishes a simple rotating pulse generator, engine driven at engine speed, an ignition transformer for each cylinder, and resistor type spark plugs. High potential leads from transformer to spark plugs are shielded and insulated to prevent both arcing and capacitance current surges, thus providing protection for the operator.

The system of spark ignition is practically fool proof, as positive ignition and permanent timing is inherent in the design. Freedom from trouble is assured by absence of the items mentioned above, namely breaker points, timing devices, etc.

In addition, the Model 38 spark ignition engine uses an ignition cell mounted in the cylinder liner, in which the spark plug provides ignition energy. This ignition cell provides a proper mixing of gas fuel and air for positive ignition under all practical load conditions.

The spark ignition Model 38 Opposed Piston engine will operate on natural gas, sewage gas, or propane. It can be converted in the field to a dual fuel or diesel oil engine, and engines of this design in the field now operating as a dual fuel engine can be converted to the spark ignition modification with the proper kit of factory change-over parts.



8-cylinder Model 38D8⅛ spark ignition engine.

FAIRBANKS-MORSE TWO-CYCLE MODEL 38D8⅛ OPPOSED-PISTON TYPE DIESELS

These engines are a development of extensive use in submarine and locomotive service. As marine and stationary units they are offered in four, five, six, eight, ten and twelve cylinders of 8⅛ by 10 in. ranging from 640 to 2400 hp up to 900 rpm. The general design of the engine is clearly shown in the transverse and longitudinal sections. Two pistons operate in a common vertical cylinder, open at each end, thus eliminating cylinder heads, intake valves, exhaust valves, rockers, push rods and head gaskets. The action of the opposed pistons is unified by the upper and lower crankshafts which are connected by a vertical shaft and gearing, as shown. As the pistons come together at the end of their compression strokes, the air charge is compressed in between the concave piston heads forming the combustion chamber. Two diametrically opposed fuel injection nozzles, each fed by an individual pump, inject into the combustion chamber. Combustion and expansion of the gases occur in the regular manner. As the lower piston approaches the end of its stroke, it uncovers the exhaust ports which surround the cylinder. The cylinder pressure drops, and then the upper piston

uncovers the scavenging air ports which also completely surround the cylinder wall.

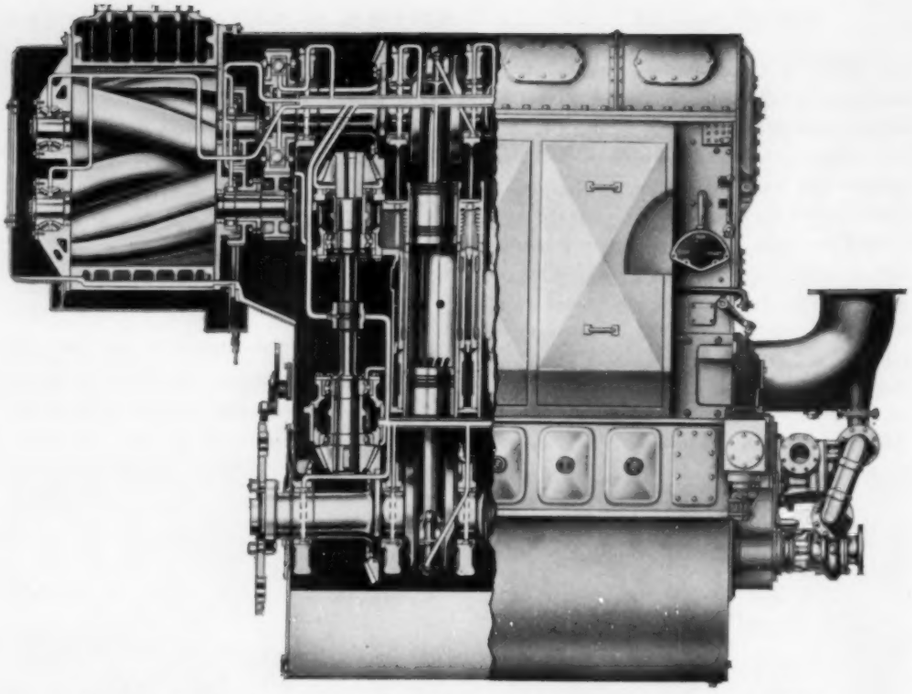
This arrangement provides a straight through scavenging action and charges the cylinder with fresh air for the next compression stroke.

CYLINDER BLOCK is the main structural part of the engine and is made of steel plates welded together into a unit that is compact, strong, rigid, and light in weight. Transverse vertical members with horizontal decks form enclosures, bearing housings and fastenings for the operating parts. Horizontal decks are bored to receive the cylinder liners along the center line of the engine. An extension is provided for attaching the scavenging blower to the cylinder block at the vertical drive end. There are compartments for control mechanisms, vertical drive assembly, upper and lower crankshafts, air passages, injection nozzles, and exhaust manifold. The air receiver and vertical drive control end compartments are provided with covers. Upper crankshaft compartment is closed with a sheet metal top cover having several convenient inspection covers over the cylinders. The oil pan closes the lower crankcase compartment with explosion proof covers at the bottom. Suitable covers complete the closure at the sides.

CYLINDER LINER is of high tensile strength close-grained cast iron which increases the liner life very materially. A steel sleeve water jacket covers the middle working length of the liner; water joints are sealed by rubber rings, and a locking ring prevents any possiblity of working loose longitudinally. The lower end of the liner fits into a water jacketed section of the cylinder block. The upper portion of the liner is cooled by the surrounding scavenging air, in the scavenging air receiver. Vertical ribs around the combustion space strengthen this section and increase the effective cooling water surface. Openings in the side of the liner and liner jacket provide for the two fuel injection nozzles, an air start check valve, and a cylinder relief valve. These cylinder liners enter the cylinder block from the top, and are bolted in place by flanges at the top of the liner.

CRANKSHAFTS are made of chrome-nickel-molybdenum steel alloy with precision-machined bearing surfaces. Blower drive gear is secured to the upper crankshaft with a key and retainer plate, while at the opposite end is the camshaft driving chain sprocket and starting air distributor camshaft. The governor and all attached pumps are driven from the forward end of the crankshaft.

Power is taken from the engine through a coupling mounted on the lower crankshaft at the blower end. The vertical shaft connecting the upper and lower crankshafts is made up essentially of three pieces: the upper and lower pinion shaft and the flexible interconnecting shaft arrangement. Each pinion shaft runs in a large roller bearing next to the pinion and is further supported by a substantial thrust bearing. The flexible interconnecting shaft arrangement compensates for expansion, giving torsional flexibility, and provides for relative timing of upper and lower shafts.



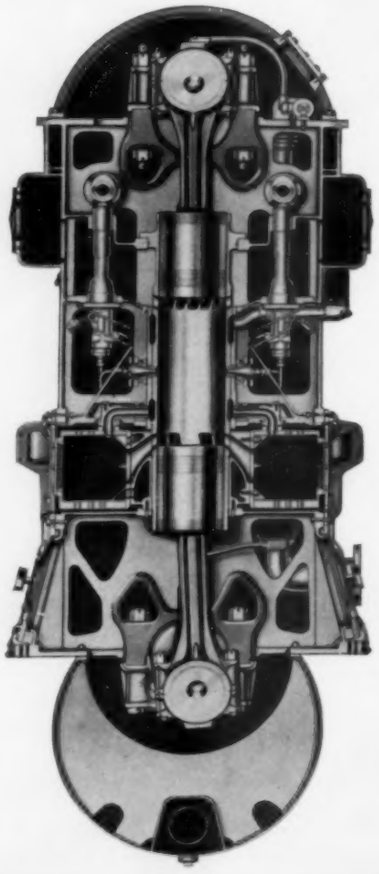
Longitudinal section, showing vertical crankshaft drive, pistons, upper and lower crankshaft and cylinders.

Upper and lower crankshafts have a thrust bearing next to the vertical drive gears, and plain main bearings at each transverse vertical member of the cylinder block between each two cylinders.

CONNECTING RODS AND PISTONS, upper and lower, are of similar design. Rods are drop forged and drilled to carry oil to the piston pins. Crankpin ends of rods have precision type shells. Two bolts hold the cap in place, and no shims are used between bearing shell halves. Piston pin bearing consists of a cast bronze lining floating in the steel bushing in the connecting rod eye. Pistons have oil-cooled crown with smooth cylindrical outer surface. Piston pin is carried in the piston pin insert, which is bolted to the inside of the piston body. Each piston has four compression rings, and three oil control rings. Both pistons may be removed from the cylinder at the lower end and out through the openings at the side of the crankcase.

MAIN and CRANKPIN "NO SCORE" BEARINGS are of the precision type and are machined from wear resistant aluminum alloy. These bearings were first perfected for Diesel engines by Fairbanks-Morse engineers. Along with the development of these bearings, crankshaft journals of proper quality were designed to be compatible with the aluminum alloy bearings. Experience with these bearings proves that they are almost indestructible and if properly re-installed after each inspection should last indefinitely.

CAMSHAFTS run along the engine on both sides in the upper part of the cylinder block.



Transverse cross-section, showing arrangement of pistons, porting, camshaft and fuel injectors.

SCAVENGING AIR is supplied to the cylinders by a positive displacement type blower. The blower housing contains inlet and outlet passages enclosing two three-lobe spiral impellers rotated by timing gears driven by a flexible gear drive from the upper crankshaft. Impellers run with close clearances but without actual contact. For reversing marine engines, suitable valves are furnished. The scavenging air is conducted to the air receiver compartment extending the entire width and length of the cylinder block and completely surrounds the cylinder liners at the air inlet ports.

EXHAUST MANIFOLDS are water-jacketed passages built into the cylinder block and provide a free flow for the gases to the end of the engine then in piping to the atmosphere. Covers on the control side are equipped with pyrometer thermocouples.

FUEL SYSTEM includes an engine driven supply pump which takes fuel from the service tank and delivers it through the strainer-filter to the headers serving the injection pumps. A regulating valve maintains a constant pressure in the headers and returns the surplus to the service tank. Injection pumps are constant stroke, single valve, rotating plunger type. The governor controls the fuel racks to rotate the plungers to deliver the correct quantity of fuel to the cylinders.

LUBRICATION is by pressure feed to all parts. The pressure pump is driven from the lower crankshaft at the free end of the engine, takes its suction from the sump in the lower pan, and delivers through a cooler to the engine distribution headers. Oil delivered to the main bearings passes through the crankshaft to the crankpins, through the connecting rods to the piston pins, and cools the piston crown.

COOLING WATER is circulated in a closed system. Single or double pumps, as may be required by the conditions, are separate motor driven or attached to the engine and driven from the control end of the lower crankshaft. The water is circulated through the heat exchanger, if one is used, and the oil cooler.

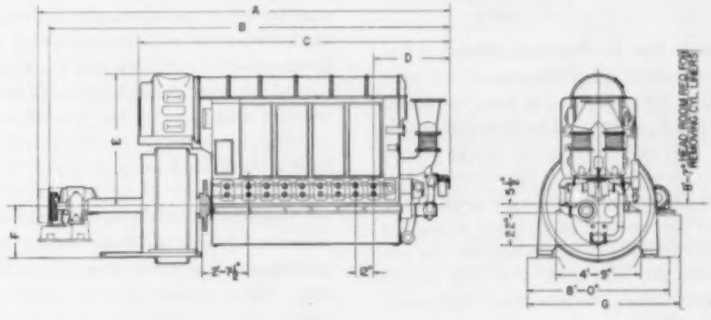
STARTING is usually by compressed air with valves in the cylinders timed by the pilot valves around the distributor.

Direct current Diesel electric drive jobs may have starting windings in the generators, and air starting can be omitted.

Ratings listed below are for continuous operation at 720 RPM. These units are also available at speeds up to and including 900 RPM with corresponding increases in horsepower and kilowatt capacity. In addition, all Model 38D8⅛ engines are offered with turbo-charging with increased ratings up to fifty percent above the ratings listed.

CONTROL of both the stationary and marine engine is by a single lever. The marine engine is maneuvered and speed is controlled by this lever.

EQUIPMENT includes necessary gauges and thermometers, and pyrometer for exhaust gases.

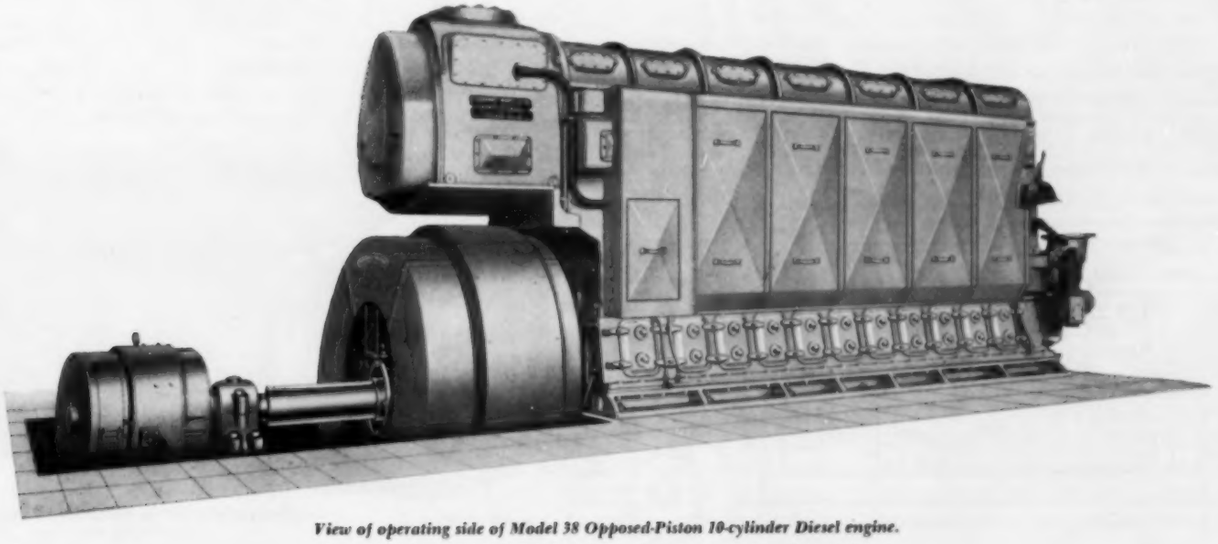


PRINCIPAL DIMENSIONS

Name of Model	38D8⅛S					
No. of Cylinders	4	5	6	8	10	12
A	17'-10 7/16"	19'-6 7/16"	20'-11 11/16"	23'-2 7/16"	25'-2 7/16"	27'-4 1/16"
B	17'-8 1/16"	19'-2 13/16"	20'-7 11/16"	22'-5 11/16"	24'-5 11/16"	27'-4 11/16"
C	13'-0 1/16"	14'-0 1/16"	14'-7 5/16"	17'-1 1/16"	19'-4 1/16"	22'-4 1/16"
D	4'-3 1/16"	4'-3 1/16"	4'-3 1/16"	4'-3 1/16"	4'-3 1/16"	4'-7 1/16"
E	7'-5"	7'-5"	7'-5"	7'-5"	7'-5"	8'-0"
F	2'-3"	2'-3"	2'-3"	2'-10½"	2'-10½"	2'-10½"
G	8'-4½"	8'-7½"	8'-7½"	8'-9"	8'-9"	8'-9"

Rating @ 450-900 RPM. (continuous)	400-800	500-1000	600-1200	800-1600	1000-2000	1200-2400

All Model 38D8⅛ opposed piston engines are offered with turbo-charging with increased ratings up to 50% above ratings listed.



View of operating side of Model 38 Opposed-Piston 10-cylinder Diesel engine.

FAIRBANKS-MORSE 2 CYCLE 38F5-1/4 OP TYPE DIESELS

The Model 38F5¼ line of engines has made an enviable name for itself since the time of its introduction to the trade. Like its big brother, the Model 38F5¼ is suitable for a large variety of applications, and is capable of highly economical and trouble free performance over a wide speed range. This model is offered for application in marine, stationary, industrial, railway and mobile installations and can be furnished for either diesel, dual-fuel, or spark-ignited operation. The engines are available as complete packaged units which can be quickly installed and placed in service, inasmuch as all accessories required for operation of the engine are attached to the frame of the engine.

During World War II, Fairbanks, Morse & Co. manufactured several hundred units of the same general design, but prior to this time, the Model 38 5¼ x 7¼ O.P. engine had been available only to the U. S. Navy and other agencies of the Federal Government. Its present design represents years of research and improvement which now makes it possible to offer this unusual shock proof engine for all fields of application. These engines, for stationary service, are built in 4, 5, 6, 7, 8 and 10 cylinder modifications, with a bore and stroke of 5¼ x 7¼. The power range extends from 150 to 850 hp with higher ratings for special applications.

The general design is characterized by a pair of pistons in each cylinder, operating in opposite directions, and with a common combustion space formed by the heads of the pistons. The upper pistons, controlling the scavenging air inlet ports, are connected to an upper crankshaft, and the lower pistons, controlling the exhaust ports, are connected to a lower crankshaft. The engines are complete self-contained units with attached rotary type blower for supplying scavenging air and equipped with attached pumps and auxiliaries as required.

The CYLINDER BLOCK, which is the main structural part of the engine, is fabricated from flame cut, heavy steel sections, and is welded into an exceptionally compact and rigid unit. After welding, the block is sandblasted, stress-relieved and magnaflux tested to check all vital points. The air receivers and air ducts from the blower are an integral part of the block, thus adding to its rigidity. Guiding lands are accurately machined into the block for precise cylinder liner fitting. Upper and lower crankshaft bearing saddles are an integral part of the cylinder block and are line bored, thus assuring alignment of the crankshafts. Spacious openings, conveniently located, permit easy access to all cylinder block compartments.

CRANKSHAFTS AND VERTICAL DRIVE—The upper and lower crankshafts act together in transmitting power to the drive end of the lower crankshaft. This is accomplished by a bevel gear driven, flexible, vertical drive, located at the drive end of the engine. A portion of the power from the upper crankshaft is used in driving the scavenging air blower. The crankshafts are made from a high-strength cast iron alloy, cast with integral counterweights and cored for lightness to minimize main bearing loads. They are further balanced both statically and dynamically to obtain vibration free operation. A large thrust bearing is provided at the drive end of the engine.

The precision main bearings are machined from wear-resistant aluminum alloy for durability. To improve crankshaft and bearing alignment, the forged steel main bearing caps are mortised into the engine frame. When required, torsional dampers are attached to the crankshaft to eliminate critical speeds. The vertical drive shaft turns in large tapered roller bearings. Torsional flexibility is provided by the flexible shaft design.

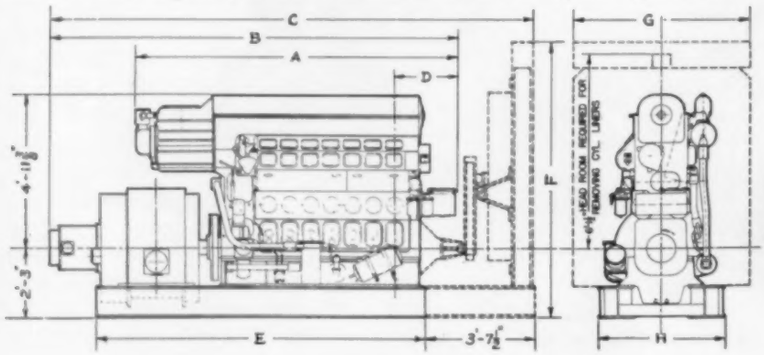
CYLINDER LINERS—The interchangeable cylinder liners are cast from a close-grained iron of high tensile strength. They are then heat-treated and stress-relieved to insure strength and durability. The liners are uniquely designed to provide both adequate cooling and rigidity of structure. Sturdy steel water jackets are fitted onto the liners around their middle or combustion area, where they also support combustion forces. The cooling water flows through the fluted passages formed by the liner and the fitted water jacket. The upper part of the liner is cooled by scavenging air, while the lower part is cooled by the water which circulates through the exhaust manifold housing. Large inlet and exhaust ports are located around the entire liner circumference. Inlet ports are slanted to give the scavenging air increased turbulence, thereby providing a better air-fuel mixture. The pistons of each liner form the combustion space, thus eliminating cylinder heads and minimizing heat losses which would decrease efficiency.

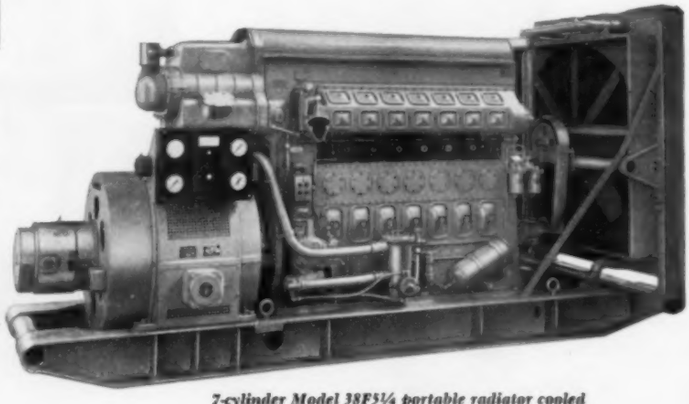
PISTONS, CONNECTING RODS AND BEARINGS—The two pistons form a nearly spherical combustion chamber as they converge mid-way in each cylinder. Each piston is fitted with three compression rings at the closed end and three oil rings at the open end.

Model No.	38F5¼ STATIONARY					
No. of Cylinders	4	5	6	7	8	10
A	7'-11⅝"	9'-0¾"	9'-4¾"	10'-6½"	11'-4¼"	13'-1¾"
B	10'-10 9/16"	11'-8 13/16"	12'-6 1/16"	13'-4 1/16"	14'-0 1/16"	15'-5 1/16"
C	13'-11"	14'-7¾"	15'-5½"	16'-2½"	16'-10"	18'-4½"
D	24¼"	2'-1¼"	2'-1¼"	2'-1¼"	2'-2⅝"	2'-2⅝"
E	8'-3"	9'-2"	9'-10"	10'-6"	11'-0"	12'-10½"
F	7'-4⅜"	7'-4⅜"	7'-6⅛"	7'-6⅛"	7'-7¾"	8'-5⅛"
G	4'-7¼"	4'-7¼"	5'-0⅝"	5'-0⅝"	5'-0⅝"	5'-10¾"
H	3'-11¼"	3'-11¼"	3'-11¼"	3'-11¼"	4'-10½"	4'-11"

Rated HP (continuous)	150-340	188-425	225-510	263-595	300-680	375-850
Rated Speed	600-1300	600-1300	600-1300	600-1300	600-1300	600-1300

Continuous rating of 85 HP per cylinder is available at 1300 RPM for approved applications.





7-cylinder Model 38F5¼ portable radiator cooled generating set.

A full floating piston pin is supported in the piston and in the connecting rod eye. The drop-forged connecting rods are made from an alloy steel of high tensile strength. The aluminum crankpin and main bearing shells are sufficiently large to carry bearing loads exceeding the engine rating. Granted proper installation after inspection or overhaul, they should give a service life unequalled by any other bearing.

SCAVENGING SYSTEM—The scavenging air blower is of the positive displacement, rotary lobe type, and is driven through a flexible drive arrangement by the upper crankshaft. Positive uniflow scavenging permits a thorough air-fuel mixture, and sweeps out all products of combustion. The positive displacement blower supplies air into the large air receivers on both sides of the engine. During the power stroke, the lower pistons uncover the exhaust ports before the upper pistons uncover the inlet ports. Thus, most of the exhaust gases escape before the scavenging air enters the cylinders. During the compression stroke, the inlet ports remain open after the exhaust ports are closed. This allows scavenging air to continue entering the cylinders, resulting in a complete filling of the cylinder with air for combustion.

EXHAUST SYSTEM—Tangential scavenging ports completely surround the upper part of the cylinder liners, and the exhaust ports completely surround the lower part. Cylinders are swept clean of combustion gases by the downward and unrestricted flow of scavenging air. The exhaust manifolds, one on each side of the engine are water cooled and may be removed from the cylinder block. The exhaust manifolds have openings of ample size for exhaust port, piston and ring inspection. Thermocouples for indicating the exhaust temperatures of individual cylinders may be inserted in the manifold covers. A fitting at the forward end of the engine receives the exhaust gases from both manifolds and is flanged to permit piping to the silencer.

FUEL OIL SYSTEM—The entire fuel system, with the exception of the fuel supply tank, is engine mounted. A positive displacement, rotary gear type pump supplies fuel oil to the individual injection pumps. Each cylinder receives fuel oil from these injection pumps through an injection nozzle. The injection pumps are operated through a tappet assembly from a camshaft on the control side of the engine. Injection pumps and nozzles are readily accessible through large, conveniently located openings on the cylinder block. The entire fuel oil system is adequately protected by the inclusion of strainer-filters of the most efficient design.

LUBRICATING SYSTEM—The engine is equipped with a pressure lubrication and piston cooling system which supplies a continuous flow of oil to all surfaces requiring lubrication, and to the pistons for cooling. The engine pressure system consists of a positive pressure gear type pump, an upper and lower oil header fastened to the cylinder block and connections to bearings and other points requiring lubrication. Through supply pipes from both lower and upper headers, oil is forced to each main bearing, through the crankshaft passages to each crankpin bearing. From each crankpin bearing, oil passes through the drilled passage in the connecting rod to the piston pin bearings and to the piston for cooling.

The camshaft receives lubrication from the upper oil header. The oil flows into and fills the hollow camshaft from a connection at the exhaust end. Small openings at each bearing and at each cam allow oil to reach the bearing surfaces and the tappets. Lubricating oil draining from the exhaust end of the crankcase lubricates the timing chain drive arrangement. Oil from special tubing liberally lubricates the blower drive gears and bearings, the vertical drive gears, pump drives and governor drive.

COOLING WATER SYSTEM—This engine utilizes a closed, soft water cooling system. The water enters the passages in the cylinder block closed by the exhaust manifold and circulates around the manifold and the exhaust port area. Special connections carry the water from the manifold to the cylinder lining water jacket. From the liner water jacket the water is piped to an outlet water header where it is returned to the heat exchanger for cooling. A raw water system is used to cool the soft water and the lubricating oil.

CONTROL SYSTEM—The simple controls of this engine assure safe and reliable operation. One lever controls the starting, running and stopping of the engine. In the event of any emergency, the engine may be instantly stopped by push button control. The overspeed governor protects the engine by automatically shutting it down when the maximum safe speed is exceeded. Before the engine may be started again, the control must be unlocked by moving the reset lever which is located just to the left of the control quadrant. A Woodward hydraulic governor closely regulates the engine.

FAIRBANKS-MORSE TWO-CYCLE MODEL 33

The Model 33 engines, for stationary service are of the slow speed, heavy duty, two-cycle type, with attached scavenging pump, pressure lubrication and oil-cooled pistons. The open combustion chamber is used. The Model 33 stationary engines operate at speeds suitable for alternating current generators. This model is built in three cylinder sizes for a range of from 500 to 2000 horsepower for stationary service.

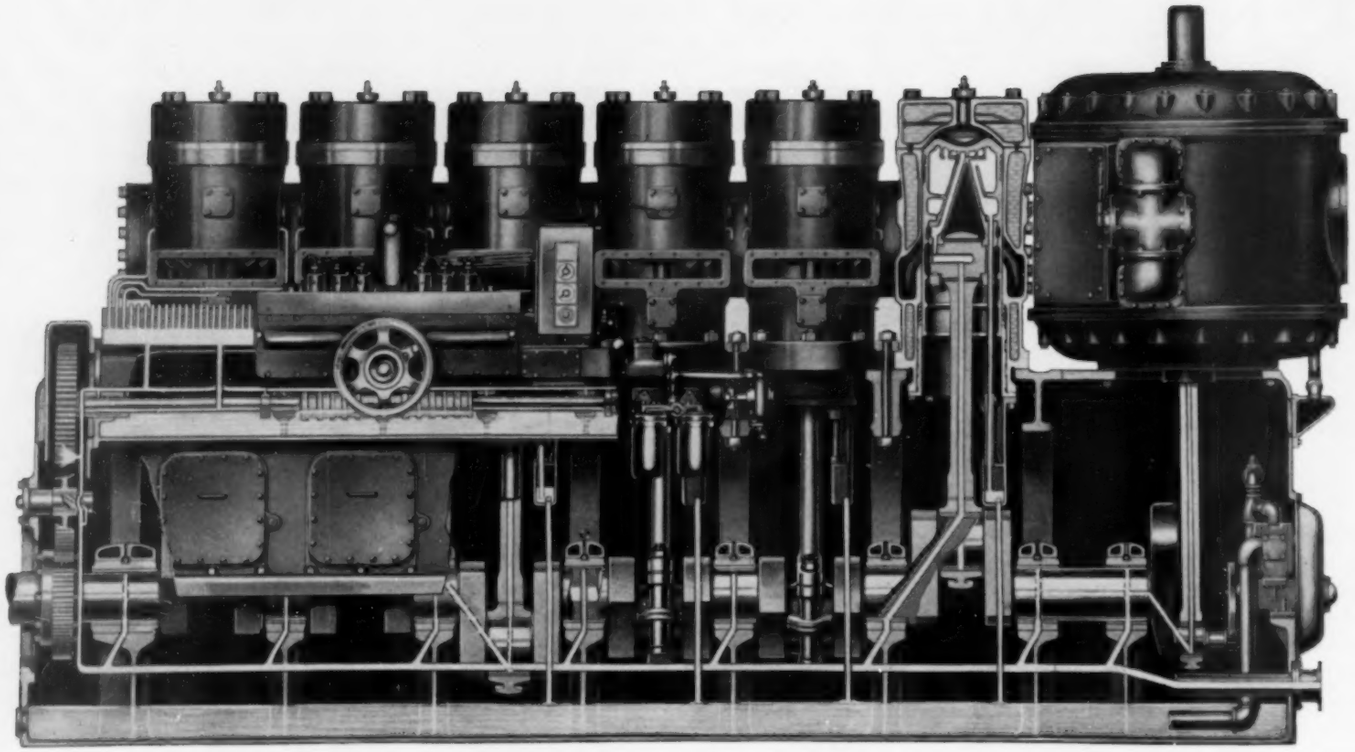
All of the engines are of similar design, and all have an attached engine-driven, double-acting, piston type scavenging pump except the ten cylinder 16 by 20 inch engine which has a separate motor-driven scavenging blower.

BEDPLATE is a single iron casting of substantial proportions with heavy transverse bridges for the main bearing supports. The lower pan of the bedplate is dropped to form a sump for the lubricating oil. Box girders along the sides provide wide flanges on the bottom for mounting the engine on the foundation and deep bosses are provided for the foundation bolts. The top of the bedplate is machined to take the upper base or crankcase.

CRANKCASE casting is in one piece of cast iron and is of box design, bolted to the top of the bedplate. It is thoroughly reinforced with transverse arched webs between the cylinders. Large openings on both sides of the crankcase give easy access to all main and connecting rod bearings. On some sizes, the camshaft housing is an integral part of the crankcase casting; while in the others, faces are provided for bolting the separate housing to the crankcase.

CYLINDERS of special grade of hard close grained cast iron are individual with liner and jacket cast integral. Large water jacket spaces extend more than the working length of the liner. Scavenging and exhaust ports are cast-in with the former carefully shaped to give complete scavenging and charging of the cylinder on the back-flow principle. The lower part of the cylinder is bored larger than the piston for four lubricating-oil wiper rings held in place by a sleeve bolted to the bottom of the cylinder. These rings prevent contamination of the main oil supply in the base sump by collecting any oil which has been in contact with the products of combustion. A small pipe header conducts the oil collected by these rings to a separate sump, whence it is passed through the purification system thence back into the circuit.

CYLINDER HEADS are individual of special grade of iron and of simple design. The inner surface is spherical in shape. The water flow is directed over the combustion chamber cooling surfaces. Fuel injector is in the center of the head. Air starting check valve in removable cage is at one side. Heads are bolted to tops of cylinders by long studs.



Longitudinal cross-section, showing details of lubricating system.

CRANKSHAFT is forged from open hearth steel by an hydraulic press. It is carefully heat treated to give high physical properties. It is machined all over in special tools to give accurate bearing surfaces. In marine engines, the thrust shaft is bolted to the flange at the after end. In stationary engines, the generator and flywheel shaft is bolted to the crankshaft driving flange.

CONNECTING ROD is die forged from open hearth steel. Cast steel babbitt lined crankpin boxes with caps are bolted to the lower end of the rod by four bolts in the smaller cylinders and two bolts in the 16 by 20 engine.

SHIMS are provided between the crankpin box and cap to allow adjustment for wear, and between the box and the rod foot for adjustment of compression when required. Fitted bolts keep the crankpin box and cap in correct alignment with each other. The upper end of the rod is provided with a large bushing of special bronze, pressed in, dowelled, and scraped for bearing fit.

MAIN BEARINGS have half round lower shells held in the bedplate by the cast caps bolted on. Both halves are lined with high grade babbitt. Shims are provided for adjustment to compensate for wear.

PISTON is of close-grained cast iron with an unbroken cylindrical shell. Symmetrical design and strong circular ribs around the inside of the piston permit light construction and eliminate possibility of distortion. There are six compression piston rings. The steel casting, which forms the piston-pin housing and which is bolted to a flange inside the piston, also forms the inner shell of the space through which oil is circulated for cooling the piston. This construction eliminates the piston-pin cross-boring which is ordinarily used in trunk piston engines.

CAMSHAFT is gear driven from the crankshaft at the flywheel end of the engine, and runs along the front of the engine in a housing at the level of the upper part of the crankcase. On the camshaft are located the fuel-injection and air-start cams, lubricator drive cams, governor drive gear, and in the 14 by 17 engines the fuel supply pump drive cam. Fuel injection pumps are grouped except in the ten cylinder 16 by 20 engine where they are located opposite their respective cylinders.

SCAVENGING PUMP is double acting piston type driven from a crank at the free end of the crankshaft. Capacity is so designed as to maintain a constant pressure of about 2 psi. in the scavenging air manifold which runs along the front of the cylinders and is attached to them. While this pump is of the same diameter for any series of the same model number, the output is varied by changing the stroke to fit the requirements of the particular cylinder combination which it serves. This piston pump has automatic intake and discharge valves. The ten cylinder 16 by 20 engine has the motor driven blower.

FUEL INJECTION PUMPS, one for each cylinder, have a constant stroke but the effective displacement is regulated by rotating the plunger, changing the quantity of fuel injected and the timing, depending on the load. The pumps are regulated by the governor. The use of a single valve for the discharge gives the pump its name of "univalve." These injection pumps are kept under a slight pressure on the suction side by the engine driven supply pump. A filter is included.

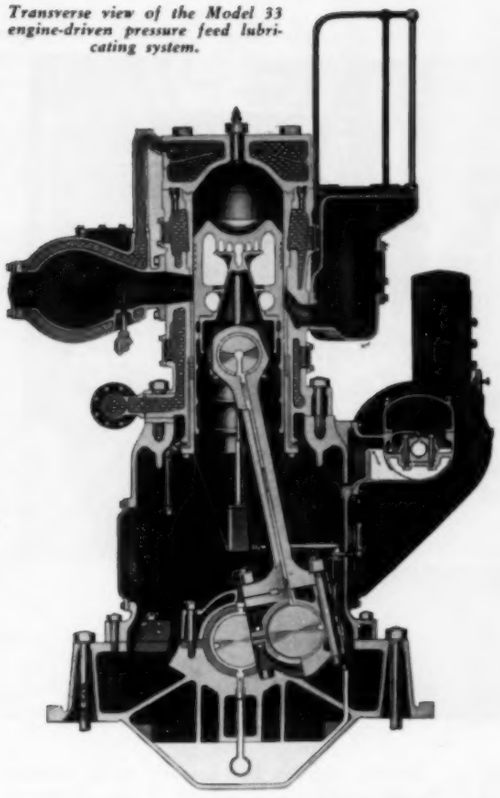
LUBRICATION is by pressure feed from the engine driven oil pump at the free end of the engine. Suction is from the bedplate sump, and delivery is through an oil cooler to the distribution header in the engine, and to the bearings. Piston cooling oil is taken from the piston pins in this circuit and is returned through telescopic pipes to the crankcase sump. The force feed lubricator is kept filled automatically from pressure system and delivers oil to cylinder wall feed lines.

STARTING is by compressed air. The starting valves in the cylinder heads are timed by the master control.

COOLING WATER is supplied by separate motor driven pumps or by built-in centrifugal pumps driven from the forward end of the engine, as conditions may require. The closed cooling system with heat exchanger is used in all cases, and when needed, double pumps are furnished.

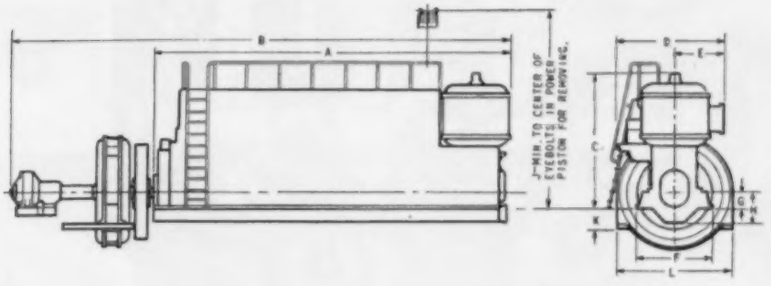
EQUIPMENT DETAILS vary to suit conditions. All engines have water-cooled cast iron exhaust pipes. Stationary engines have flywheels according to the needs of the individual installation. Woodward isochronous governors are fitted when required by the operating conditions. Independent overspeed governors are fitted to stationary engines.

Transverse view of the Model 33 engine-driven pressure feed lubricating system.



PRINCIPAL DIMENSIONS

Model No.	33F12		33E14			33F16					
No. Cylin.	5	6	5	6	7	4	5	6	7	8	10
A	14'-4¼"	16'-8¼"	15'-11¼"	18'-1¾"	20'-4"	17'-2"	19'-8"	22'-2"	24'-8"	27'-2"	29'-11¼"
B	24'-2½"	27'-0¾"	25'-11⅞"	28'-2¾"	31'-5"	28'-2¾"	30'-8¾"	33'-2¾"	35'-5¾"	37'-11¼"	39'-5⅝"
C	7'-9¾"	7'-9¾"	8'-10¼"	8'-10¼"	8'-10¼"	10'-8"	10'-8"	10'-8"	10'-8"	10'-8"	9'-7"
D	5'-11"	5'-11"	6'-4⅛"	6'-4⅛"	6'-4⅛"	7'-7⅛"	7'-7⅛"	7'-7⅛"	7'-7⅛"	7'-7⅛"	7'-8½"
E	2'-11½"	2'-11½"	3'-5½"	3'-5½"	3'-5½"	3'-8¼"	3'-8¼"	3'-8¼"	3'-8¼"	3'-8¼"	3'-8¼"
F	4'-3"	4'-3"	5'-3"	5'-3"	5'-3"	5'-9¼"	5'-9¼"	5'-9¼"	5'-9¼"	5'-9¼"	5'-9¼"
G	6"	6"	6"	6"	6"	15"	15"	15"	15"	15"	15"
H	22½"	22½"	2'-1½"	2'-1½"	2'-1½"	2'-4"	2'-4"	2'-4"	2'-4"	2'-4"	2'-4"
J	10'-5"	10'-5"	13'-6"	13'-6"	13'-6"	14'-4"	14'-4"	14'-4"	14'-4"	14'-4"	14'-4"
K	2'-4½"	2'-4½"	2'-4½"	2'-4½"	2'-4½"	19½"	19½"	19½"	19½"	19½"	2'-0"
L	6'-6½"	6'-6½"	7'-7"	7'-7"	7'-7"	7'-7"	8'-8"	8'-8"	8'-8"	8'-8"	10'-1"
Ratings BHP Net.	500	600	575	690	805	800	1000	1200	1400	1600	2000
Rated Speed	400	400	300	300	300	300	300	300	300	300	300



FAIRBANKS-MORSE TWO-CYCLE MODEL 31A

Model 31A engines are offered for stationary service in two cylinder sizes, 6¼ by 9 inches and 8½ by 11½ inches in from five to eight cylinders to cover the range from 175 to 520 horsepower. Also the 18 by 27 inch cylinder is built in six, eight and ten cylinders for stationary service ranging from 2100 to 3500 horsepower. All of these engines are of similar design, of two-cycle type, en-bloc construction, and have many special features. The sectional views shown here give many of the details.

EN-BLOC FRAME in the smaller engines is a single iron casting, incorporating both crankshaft bearings and cylinder bores in the one piece so that proper alignment between the two is assured. However, because of size, the 18 by 27 crankshaft is bedded in lower base. Its depth and wall construction give great rigidity without excessive weight. Large openings on both sides of the block afford easy accessibility to all main and connecting rod bearings. The one-piece cylinder block serves as a mounting for the cylinders, crankshaft, camshaft, and injection pumps, assuring proper alignment permanently among these parts. There are no cored water or lubricating oil passages in the block. Cylinder liners are mounted to permit free expansion at the lower end, and the employment of the integral water jacket avoids the necessity of a water seal at this point. Crankshaft is assembled in the lower part of the block, held by heavy bearing caps.

CYLINDER LINER is a one piece casting including its water jacket, of high tensile close grained iron. Scavenging and exhaust ports are cast in the sides to register with the proper passages and manifolds in the en-bloc frame. Bore of liner is accurately machined and honed. Cooling water enters the liner near the bottom and internal passages between top of the liner and head provide uniform distribution of water flow. The cylinder head is cored to accommodate a separate air starting valve cage and a compression relief valve body.

CYLINDER HEAD of special cast iron is bolted to the top of the liner casting. It is fully water cooled with particular attention to that portion of the head surrounding the fuel injection nozzle in the center. An air starting valve in separate cage is at one side, and there is an indicator opening is also provided. Water and starting air manifolds, connected to the head, are arranged to permit lifting the head without disturbing either manifold.

CRANKSHAFT is a one-piece casting of high strength semi-steel alloy except on 31A18, where forged shaft is used. Large main and crankpin journals are used with webs designed to give great rigidity of structure. Crankpin and main journals are cast hollow on the smaller engines. All bearing surfaces are carefully machined, ground, and lapped. Crankshaft is dynamically balanced. Suitable passages in the shaft lead oil from the main journal to the crankpin.

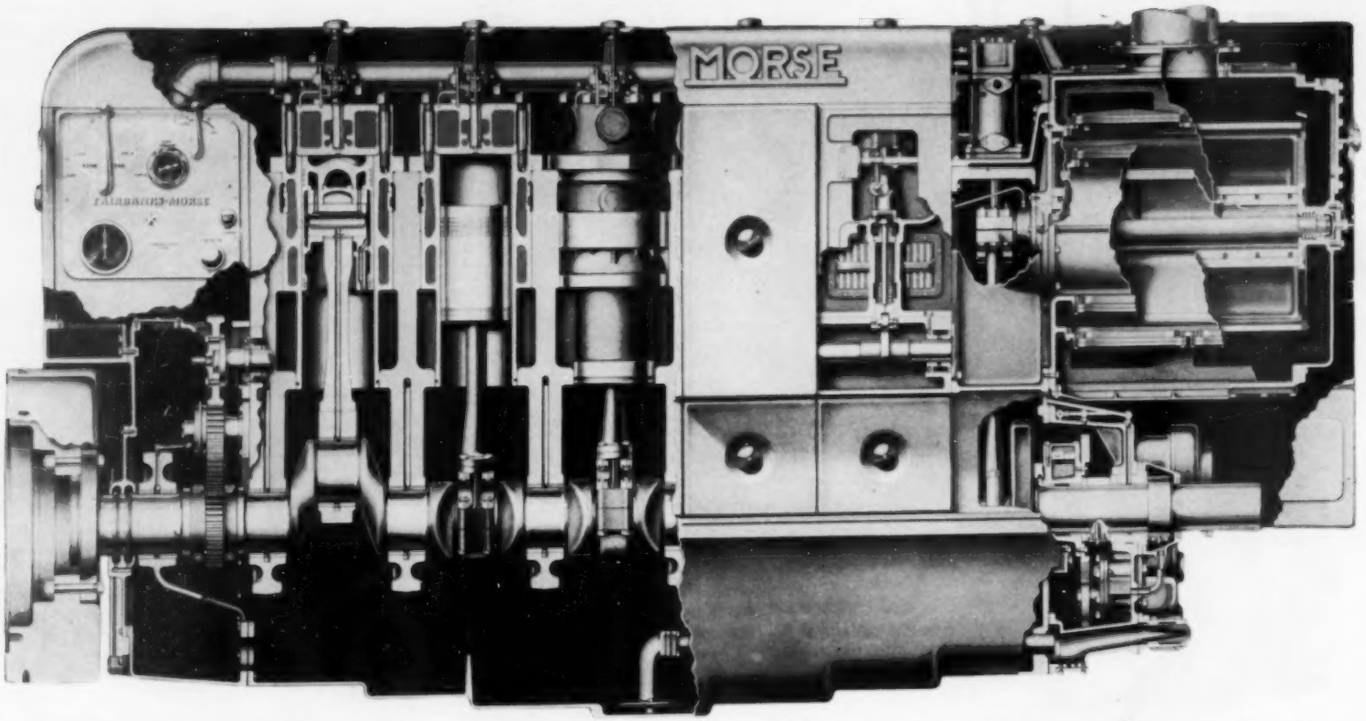
MAIN BEARING SHELLS of aluminum are precision made interchangeable top and bottom, and may be easily rolled out for inspection. The main bearing shells are also interchangeable with the crankpin bearing shells, on the smaller engines.

CONNECTING ROD is of steel, forged and turned. Upper end is fitted with precision type bronze bushing. Lower end crankpin bearing shells are held in cast iron boxes of special construction with two sets of bolts; one set to connect the rod to the upper box, and the other set to clamp the two boxes together.

PISTON is of trunk type and of close grained cast iron; a simple symmetrical casting with unbroken outer wall and strong circumferential ribs inside to hold the piston true to shape. Piston pin is carried in a one-piece bracket bolted to the inside of the piston. Cylinder compression is adjusted by means of shims between the conn. rod box and conn. rod foot. Piston has four compression rings, and at the lower end of the skirt, two oil control rings. Combustion chamber is largely formed in the top surface of the piston. The under side of the crown is cooled by oil from the lubricating system taken from the piston pin bearing. Oil from the piston crown is drained into the crankcase sump. These pistons may be removed without disturbing the connecting rod bearings because of the connecting rod lower end construction. An additional oil spreader ring is included in the upper portion of the piston in the Model 31A18 engines.

EXHAUST MANIFOLD is fully enclosed and water cooled on the smaller units. It is of generous size to permit an unrestricted flow of the exhaust gases from the engine length. Large inspection covers are provided in the exhaust manifold so that cylinder liner, piston rings, and the piston may be easily inspected through the exhaust ports. Thermocouples are located in the manifold adjacent to the exhaust ports of each cylinder. Cooling water enters

Longitudinal section of Model 31A 8½ diesel engine.



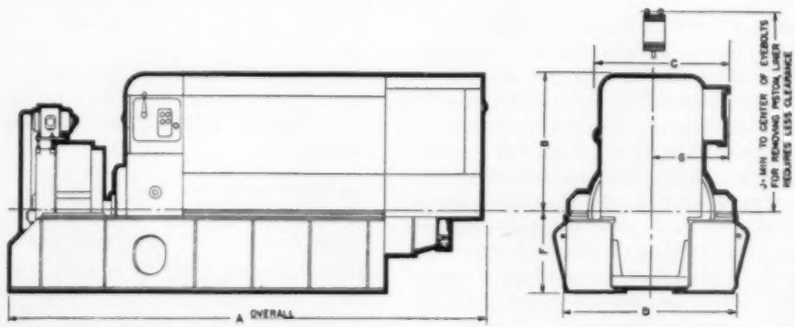
the engine through the exhaust manifold jacket and thence directly into the individual cylinder jackets. All cooling water passages of the engine can be drained through a plug provided in the exhaust manifold jacket.

CAMSHAFT has integral fuel injection pump cams and is drop forged, with cam profiles heat treated and hardened. Shaft rotates in pressure lubricated, precision type bearings which are supported by the cylinder block. Camshaft is located close to the fuel injection pumps and actuates them through a tappet assembly. Camshaft is driven by gear train from the flywheel end of the crankshaft.

SCAVENGING AIR for Models 31A6¼ and 31A8½ is supplied by a balanced, oscillating type, positive displacement blower built into the main cylinder block and driven from the forward end of the crankshaft. A large pressure-lubricated sleeve bearing is provided at the driven end of the blower shaft. At the opposite end is a grease packed double row anti-friction bearing. The Model 31A18 is furnished with a separately driven blower, or an attached blower of the oscillating type. Scavenging air is admitted to the cylinder through a set of low-resistance, automatic leaf type valves, permitting the scavenging ports to be closed after the exhaust ports. This eliminates the effect of pressure surges in the exhaust pipe and at the same time makes the air pressure in the cylinder equal to the scavenging air pressure at the moment of port closing.

FUEL INJECTION PUMPS are individual of univalve type with variable beginning of injection to retard the timing at reduced speeds and loads. Pumps are located adjacent to each cylinder and connected to the injection nozzles by short, equal lengths of high pressure tubing. Built-in fuel pump of positive displacement gear type transfers fuel from the service tank to the injection pump manifold where it is maintained under constant pressure by a regulating valve. A primary filter is used in the low pressure fuel line, and in addition, each injection nozzle has its own built-in filter to give further protcetion. The main fuel injection pumps on the Model 31A18 engines are of the univalve variable ending type. They control the amount of fuel injected into the combustion chamber.

Engine is controlled by built-in hydraulic type governor with characteristics designed particularly for stationary service. Governor setting may be readily adjusted from the control panel or by remote control.



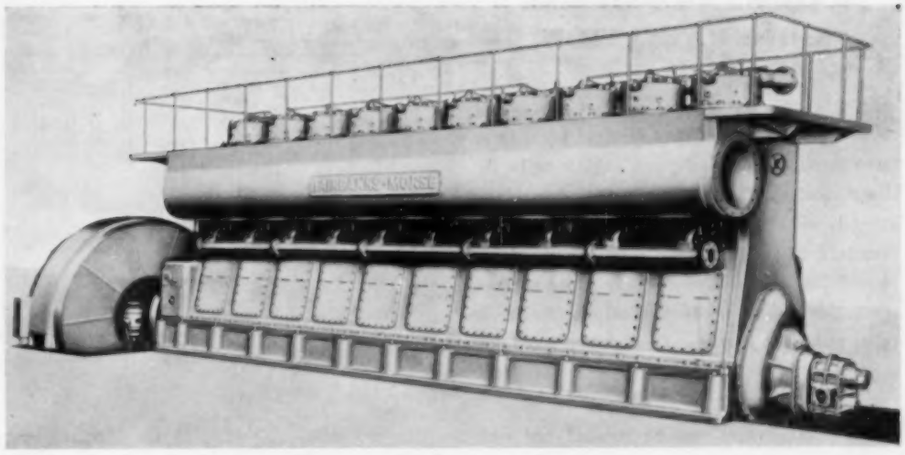
PRINCIPAL DIMENSIONS (Generating Units)

Model Number	31A6¼AG				31A8½AG				31A6¼DG				31A8½DG			
Number of Cylinders	5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8
A	13'-2⅞"	14'-2⅞"	15'-6¾"	16'-6¾"	16'-6 3/16"	18'-0 11/16"	20'-1 3/16"	21'-8 3/16"	13'-11"	14'-11"	16'-4 11/16"	17'-4 11/16"	17'-0 11/16"	18'-5 7/16"	20'-9 7/16"	22'-1 11/16"
B	3'-9 3/16"	3'-9 3/16"	3'-9 3/16"	3'-9 3/16"	4'-8⅛"	4'-8⅛"	4'-8⅛"	4'-8⅛"	3'-9 3/16"	3'-9 3/16"	3'-9 3/16"	3'-9 3/16"	4'-8⅛"	4'-8⅛"	4'-8⅛"	4'-8⅛"
C	3'-3¼"	3'-3¼"	3'-3¼"	3'-3¼"	4'-7½"	4'-7½"	4'-7½"	4'-7½"	3'-3¼"	3'-3¼"	3'-3¼"	3'-3¼"	4'-7½"	4'-7½"	4'-7½"	4'-7½"
D	4'-10"	4'-10"	4'-10"	4'-10"	6'-1"	6'-1"	6'-1"	7'-2"	4'-10"	4'-10"	4'-10"	4'-10"	6'-2⅝"	6'-2⅝"	6'-2⅝"	6'-2⅝"
F	2'-2⅝"	2'-2⅝"	2'-2⅝"	2'-2⅝"	2'-9½"	2'-9½"	2'-9½"	3'-0⅝"	2'-2⅝"	2'-2⅝"	2'-2⅝"	2'-2⅝"	3'-0⅝"	3'-0⅝"	3'-0⅝"	3'-0⅝"
G	23 1/16"	23 1/16"	23 1/16"	23 1/16"	2'-8 13/16"	2'-8 13/16"	2'-8 13/16"	2'-8 13/16"	23 1/16"	23 1/16"	23 1/16"	23 1/16"	2'-8 13/16"	2'-8 13/16"	2'-8 13/16"	2'-8 13/16"
J	5'-8½"	5'-8½"	5'-8½"	5'-8½"	7'-3½"	7'-3½"	7'-3½"	7'-3½"	5'-8½"	5'-8½"	5'-8½"	5'-8½"	7'-3½"	7'-3½"	7'-3½"	7'-3½"
HP Rating	175	210	245	280	325	390	455	520	175	210	245	280	325	390	455	520
Rated Speed	720	720	720	720	514	514	514	514	720	720	720	720	514	514	514	514

LUBRICATION is by pressure feed to all parts of the engine needing oil. A built-in pressure pump at the forward end of the engine takes its suction from the sump in the oil pan under the crankcase and delivers through a filter and a cooler at controlled pressure to the engine manifold which distributes the oil as required.

COOLING WATER PUMPS are mounted at the forward end of the engine. Pumps are centrifugal type.

STARTING is by compressed air. A cam, positively positioned for ahead or astern motion, actuates the pilot valves surrounding it, which in turn time the air starting check valves in the cylinder heads. System is vented as soon as control handle is moved into run or stop position.



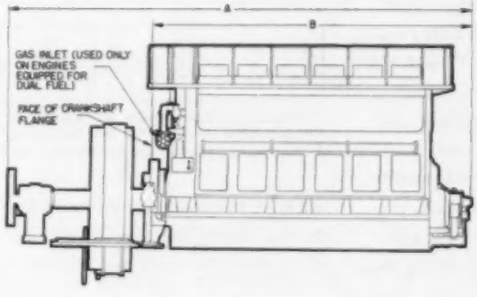
Ten cylinder Model 31AD18 diesel engine with alternator and exciter.

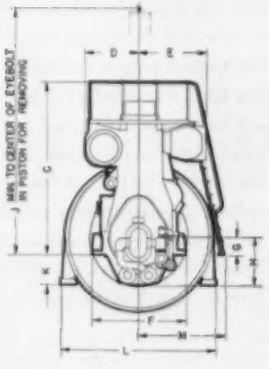
PRINCIPAL DIMENSIONS

Model Number	31A18 and 31AD18		
	6 Cyl.	8 Cyl.	10 Cyl.
A	33'-3¼"	40'-0¾"	45'-6¾"
B	22'-9¾"	28'-7¼	34'-1¼"
C	12'-0¾"	12'-0¾"	12'-0¾"
D	3'-9½"	3'-9½"	3'-9½"
E	4'-6½"	4'-6½"	4'-6½"
F	6'-5¾"	6'-5¾"	6'-5¾"
G	15"	15"	15"
H*	3'-4¼"	3'4¼"	3'-4¼"
J	17'-8½"	17'-8½"	17'-8½"
K	24¼"	24¼"	24¼"
L	11'-3"	11'-3"	11'-3"
M	6'-0¼"	6'-0¼"	6'-0¼"

HP Ratings, Net	2100	2800	3500
Rated Speed	277	277	277

*Dimension H is the distance from the bottom of the lower base to the center-line of the crankshaft.





FAIRBANKS-MORSE TWO-CYCLE MODEL 32

The Model 32 is a slow speed heavy duty stationary type Diesel Engine built in 2 cylinder sizes, from two to six cylinders in a range of 120 horsepower to 450 horsepower, it is a naturally aspirated engine with backflow principle of scavenging, using individual cylinders mounted on a sturdy cast iron base with separate crankcase compartments for each cylinder. Hydraulically forged crankshaft, and die forged rods are used with long trunk pistons. Needle bearings for the piston pin with heavy babbitted main and aluminum alloy rod bearings provide the utmost reliability for heavy duty service. These engines are started with compressed air, and are equipped with Woodward isochronous governors as optional equipment. Automatic lubrication reduces necessity for constant attendance.

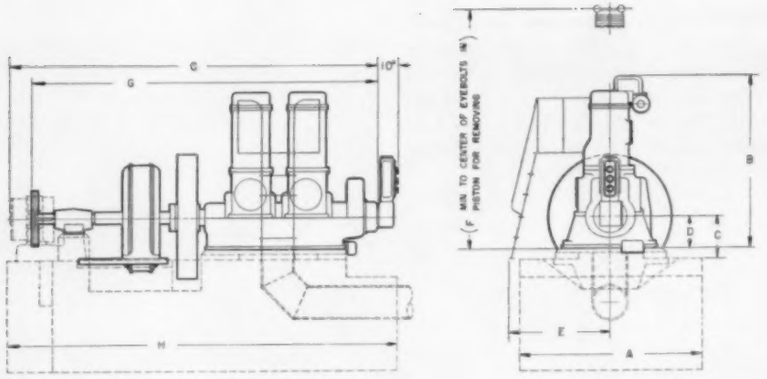
The Model 32 engines are also available as dual fuel units. In addition, existing engines in the field of the later modifications can also be converted to Dual Fuel operation with the installation of the necessary parts available from the manufacturer. This procedure is in line with the general practices of Fairbanks, Morse & Co., to make improvements in design developed by skilled and trained engineers in the field. Such procedure enables these engine owners to keep their units up-to-date and to improve efficiency, to reduce the factory of obsolescence to the practicable minimum.

FAIRBANKS-MORSE MODERNIZATION

RECENT advances in designs of marine and stationary Diesels have been so rapid as to cause many comparatively new engines to be declared obsolete. These improvements, adaptable in general to earlier models of Fairbanks-Morse Diesels, are: (1) Open head combustion and improved fuel injection system; (2) More effective scavenging with the backflow principle; (3) Needle roller piston pin bearings; (4) Constant speed governors.

These improvements may be accomplished without disturbing the basic parts of the engine and give many advantages including greater reserve power, easier and quicker starting at low temperatures, lower operating costs, lower maintenance costs due to cooler and cleaner engine, closer speed control.

HEAVY FUEL OILS are available in some territories at a price which make them very desirable from a cost standpoint. Systems have been developed which permit the use of residual fuels ranging up to No. 6 fuel oil or bunker oils. These fuels can be successfully burned in Fairbanks-Morse engines with attractive savings in fuel cost provided the proper fuel conditioning equipment is installed. The equipment usually required consists of the necessary tanks, centrifuges, oil filters, preheaters, tank heaters, etc. which provides the necessary heating, filtering and cleaning, rendering the oil in such a condition so that it may be handled by the engine injection system. In view of the many fuel oils which are available it is, in most cases, necessary to provide a specially engineered system and Fairbanks-Morse is prepared to recommend suitable equipment to handle specific fuels.



PRINCIPAL DIMENSIONS

Model Number	32E12		32E14				
Number of Cylinders	2	3	2	3	4	5	6
A	8'-0"	8'-0"	8'-0"	8'-0"	8'-0"	8'-0"	8'0-"
B	7'-6 1/16"	7'-6 1/16"	8'-4 1/16"	8'-4 1/16"	8'-4 1/16"	8'-4 1/16"	8'-4 1/16"
*C	22"	22"	27"	27"	27"	27"	27"
D	18"	18"	20"	20"	20"	20"	20"
**E	4'-6¼"	4'-6¼"	4'-10"	4'-10"	4'-10"	4'-10"	4'-10"
F	11'-4"	11'-4"	12'-7"	12'-7"	12'-7"	12'-7"	12'-7"
†G—D.C. Exciter	16'-1⅞"	18'-10⅝"	16'-11 13/16"	19'-8 13/16"	22'-5 13/16"	26'-6⅝"	29'-3⅜"
†G—V-Belted Exciter	15'-3¼"	18'-0"	16'-3"	19'-4"	21'-11"	25'-4"	28'-3"
H—D.C. Exciter	17'-0"	19'-9"	18'-1"	20'-8"	23'-10"	27'-4"	30'-1"
H—V-Belted Exciter	15'-2"	17'-10"	16'-1"	18'-10"	21'-7"	25'-2"	27'-11"

Rated BHP	120	180	150	225	300	375	450
Rated Speed	360	360	300	300	300	300	300

* Dimension shown is for low mounting. For high mounting, add 17" for 32E12 and 15" for 32E14.
**Dimension shown is for low mounting. For high mounting add 3¾" for 32E12 and 3⅛" for 32E14.
† Dimensions shown for installation with standard governor. If Woodward governor is used, add 10".

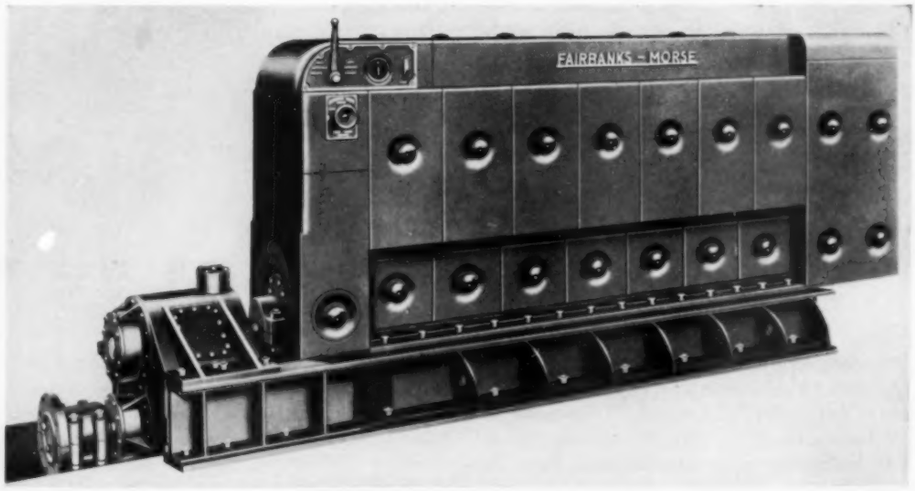
MARINE DIESEL ENGINES

Marine diesel engines are offered in the range from 5 hp up to 2400 hp in single units, and in multiples by use of multi-engine installation. Twin and triple screw applications have built up enviable records of operation in both inland waterways and in salt water service.

In addition to the small units (up to 225 hp) illustrated on the following pages, the units in the heavy duty slow speed range include the Model 31, Model 37 and Model 38 Diesel Engines. Both direct reversing and non-reversing Marine engines with suitable reverse and reduction gears are available, to meet any requirements for power and controls in the range from 10 hp to 2400 hp single screw, and larger twin and triple screw vessels.

MODEL 31 MARINE ENGINES

The Model 31 Marine Diesel Engines are available in the 6¼ x 9, and 8½ x 11½ sizes. The smaller units operate at speeds up to 720 rpm, whereas the larger bore engines are rated at 525 rpm. Construction is identical to the Model 31 stationary units except that special features are included to provide suitable lubrication, air supply and cooling for marine service.



Operating side of 31A marine diesel, showing control panel and reduction gear.

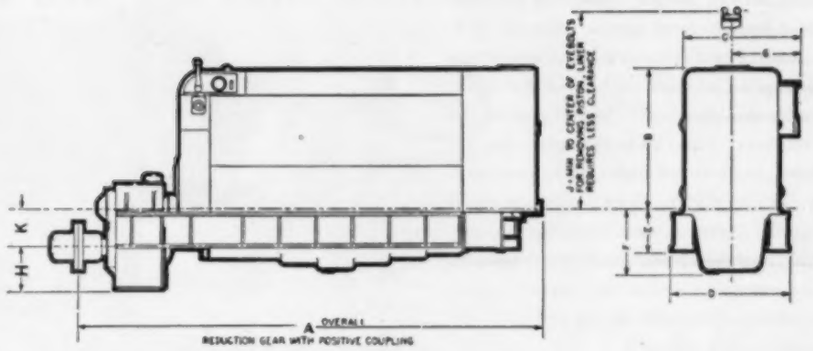
Single or double centrifugal reversible water pumps are furnished as required to provide ample cooling with either keel coolers or heat exchanger arrangement. These are mounted at the forward end of the engine, complete with drive.

Scavenging air is provided by the built in blower as described in the stationary engine. No reversing valves are required as the blower operation is identical in either direction of rotation.

Injection timing is identical for either direction of rotation. Air starting for proper direction of rotation is controlled by a double cam, positively positioned for ahead or astern motion.

Reduction gears are built-in on these direct-reversing engines, in suitable ratios to meet any requirements and to allow selection of most efficient propellor. Gears are single helical cut from heat treated alloy steel. Double cone Timken propeller thrust bearing is provided on low speed shaft. Other bearings are double row spherical roller type.

Air Compressor is built in on the marine engines, and utilizes the same drive as the scavenge blower. This compressor is water cooled. Equipment on all engines includes pressure gauges and thermometers as needed. In addition, tachometer and slow speed bilge pump are available, together with any specials required for pilot house control.



PRINCIPAL DIMENSIONS (Marine)

Model Number	31A6¼M				31A8½M			
Number of Cylinders	5	6	7	8	5	6	7	8
A	12'-8 13/16"	13'-8 15/16"	15'-0 11/16"	16'-0 11/16"	16'-4 11/16"	17'-9 3/16"	19'-9 11/16"	21'-2 3/16"
B	3'-9 3/16"	3'-9 3/16"	3'-9 3/16"	3'-9 3/16"	4'-8¼"	4'-8¼"	4'-8¼"	4'-8¼"
C	3'-3¼"	3'-3¼"	3'-3¼"	3'-3¼"	4'-7⅛"	4'-7⅛"	4'-7⅛"	4'-7⅛"
D	3'-3¼"	3'-3¼"	3'-3¼"	3'-3¼"	4'-7⅛"	4'-7⅛"	4'-7⅛"	4'-7⅛"
E	13¾"	13¾"	13¾"	13¾"	16⅛"	16⅛"	16⅛"	16⅛"
F	20 15/16"	20 15/16"	20 15/16"	20 15/16"	2'-1 11/16"	2'-1 11/16"	2'-1 11/16"	2'-1 11/16"
G	23 1/16"	23 1/16"	25 1/16"	23 1/16"	2'-8 13/16"	2'-8 13/16"	2'-8 13/16"	2'-8 13/16"
H	11"	11"	11"	11"	13"	13"	13"	13"
J	5'-8½"	5'-8½"	5'-8½"	5'-8½"	7'-3½"	7'-3½"	7'-3½"	7'-3½"
K	12¾"	12¾"	12¾"	12¾"	16"	16"	16"	16"
HP Rating	175	210	245	280	300	360	420	480
Rated Speed	720	720	720	720	525	525	525	525

MODEL 38 MARINE DIESEL ENGINES

The famous opposed piston Model 38 line of engines now offers a range of HP from 225 to 2400 at moderate speeds from 720 to 1200 RPM. The Model 38F5¼, affectionately known to the marine trade as "the lil OP", has made an outstanding name for itself as a propulsion unit and also as a marine generating unit.

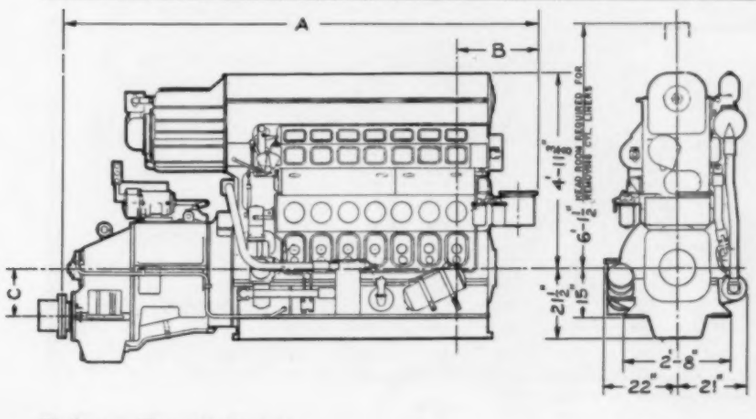
Power range of the "lil OP" extends from 150 hp to 880 hp, and the engines are built in 4, 5, 6, 7, 8, and 10 cylinder modifications. These units are completely assembled on sub-bases, including reverse reduction gears, cooling water heat exchangers, lube oil coolers, thermostatic valves, water, oil and air piping, ready to set in place quickly and easily.

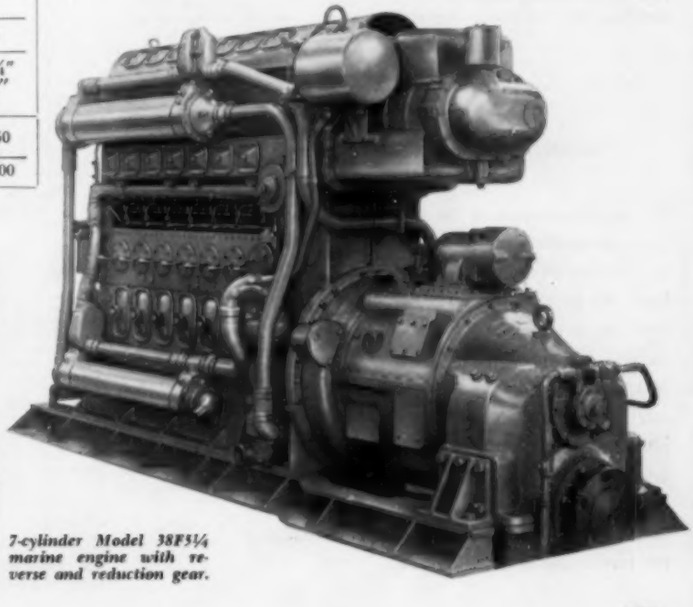
The compact design provides a maximum of power in a minimum of space; in ships engine rooms adequate access area is available to maintain and service units without sacrificing important space which can be used for other major equipment.

The outstanding servicing feature of these engines is the ability to pull pistons through the lower crankcase opening quickly and easily. At a recent exhibit, it required only two minutes to pull a piston and rod.

The opposed piston two cycle design has resulted in a reduction of 40% of parts requiring replacement. No cylinder heads, valves or valve gears and trains, or other complicated assemblies are needed with the simple and powerful assembly of these safe and dependable engines. The same features inherent in the stationary versions are included in these dependable marine engines. Continuous ratings of 85 hp per cylinder at 1300 RPM are also available on approved applications.

Model No.	38F5¼ MARINE					
No. of Cylinders	4	5	6	7	8	10
A	9'-3⅜"	10'-1¾"	11'-5¼"	12'-1½"	12'-7½"	15'-5¼"
B	24⅛"	2'-1⅛"	2'-1⅛"	2'-1⅛"	2'-2⅝"	2'-2⅝"
C	15.2"	15.2"	14⅜"	14⅜"	14⅜"	17"
Rated HP (continuous)	150-340	188-425	225-510	263-595	300-680	375-850
Rated Speed	600-1300	600-1300	600-1300	600-1300	600-1300	600-1300



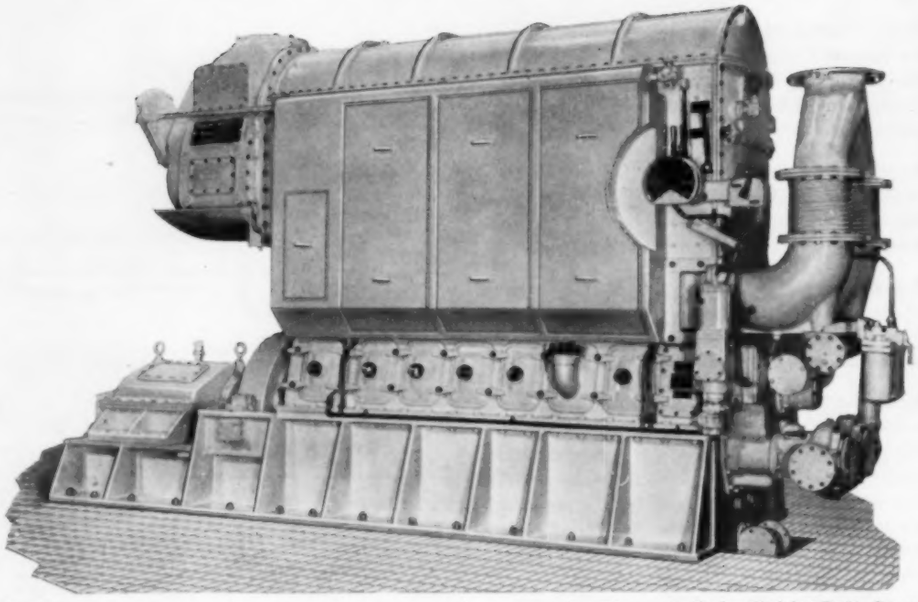


7-cylinder Model 38F5¼ marine engine with reverse and reduction gear.

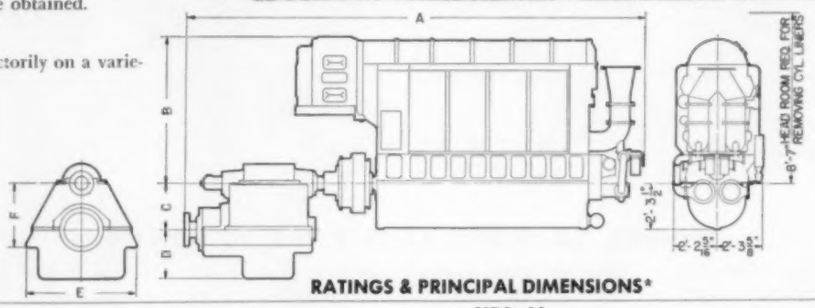
All Model 38D8⅛ marine engines are available with conservatively rated marine reduction gears with a choice of gear ratios so that the most advantageous propeller selection can be made for a given installation—thus effecting the highest possible propeller efficiency. These reduction gears are furnished complete with self contained lubricating oil systems and with built-in thrust bearings to absorb full propeller thrust in both directions. Nominal gear ratios extend from 2:1 to 4½:1, depending upon the engine horsepower and service requirements, however, gears with special gear ratios can be furnished when required.

Model 38D8⅛ engines may be combined into a multiple engine power plant driving through a two pinion gear with suitable hydraulic or electric couplings, providing up to a maximum of 7600 shp per screw. With this arrangement propeller speeds as low as 90 RPM are possible and a total shp input of over 9600 hp can be obtained.

These engines can operate satisfactorily on a variety of fuels including Bunker C.



6-cylinder Model 38D8⅛ direct reversing marine engine with reduction gear.



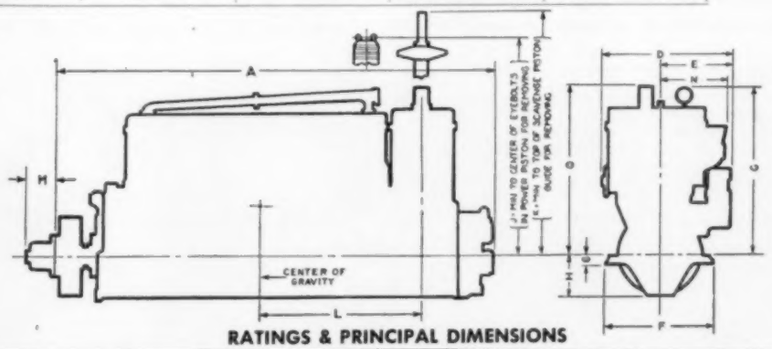
RATINGS & PRINCIPAL DIMENSIONS*

Model Number	38D8⅛M					
Number of Cylinders	4	5	6	8	10	12
A	14'-2 7/16"	15'-2 7/16"	20'-2 1/16"	22'-3 1/16"	24'-9 1/16"	27'-1 1/16"
B	7'-5"	7'-5"	7'-5	7'-5"	7'-5"	8'-0"
C	16"	16"	21"	2'-4"	2'-4"	2'-4"
D	13"	13"	2'-0"	2'-6"	2'-6"	2'-6"
E	4'-2"	4'-2"	4'-7"	5'-6"	5'-6"	5'-6"
F	2¾"	2¾"	2'-5"	3'-2½"	3'-2½"	3'-2½"
Rated HP†	640-800	800-1000	960-1200	1280-1600	1600-2000	1920-2400
Rated Speed	720-850	720- 850	720- 850	720- 850	720- 850	720- 850

*Dimensions cover direct reversing engines with vertical offset reduction gears. Units with horizontal offset gears are also available. Non reversing engines with reverse and reduction gears can also be furnished.
†All Model 38D8⅛ Opposed Piston Engines are offered with turbocharging with increased ratings of fifty percent over the ratings shown.

MODEL 37 MARINE ENGINES

For the requirement of the slow speed heavy engine application, the Model 37 marine engines are offered in three cylinder sizes, in ratings from 500 to 2100 shp. Built in propeller thrust bearings are included at the aft end of these units. As with other marine engines offered, equipment details vary to suit the conditions. Arrangements can be made to control engine or engines from pilot house or navigating bridge, as well as from the engine room itself. A major advantage of these slow speed units is the direct reversing, and the ability to connect direct to propellers, eliminating the reverse and reduction gears.



RATINGS & PRINCIPAL DIMENSIONS

Model No.	37F12		37E14			37F16				
No. Cylin.	5	6	5	6	7	5	6	7	8	10
A	17'-5 15/16"	19'-4 15/16"	19'-7 1/16"	21'-9 1/16"	24'-0 1/16"	22'-6 9/16"	25'-0 9/16"	27'-0 9/16"	29'-6 9/16"	31'-0 9/16"
C	6'-8¼"	6'-8¼"	8'-3¼"	8'-3¼"	8'-5"	----------	----------	----------	----------	----------
D	6'-6 11/16"	6'-6 11/16"	6'-4¼"	6'-4¼"	6'-4¼"	9'-1¼"	9'-1¼"	----------	----------	----------
E	3'-5 7/8"	3'-5 7/8"	3'-5½"	3'-5½"	3'-5½"	5'-1¾"	5'-1¾"	----------	----------	----------
F	4'-3"	4'-3"	5'-3"	5'-3"	5'-3"	5'-9¼"	5'-9¼"	5'-9¼"	5'-9¼"	5'-9¼"
G	6"	6"	6"	6"	6"	15"	15"	15"	15"	15"
H	22¼"	22¼"	2'-1¼"	2'-1¼"	2'-1¼"	2'-4"	2'-4"	2'-4"	2'-4"	2'-4"
J	9'-11"	9'-11"	13'-0"	13'-0"	13'-0"	13'-1"	13'-1"	13'-1"	13'-1"	13'-1"
K	12'-1 7/8"	12'-1 7/8"	12'-2"	12'-2"	12'-2"	15'-6¼"	15'-6¼"	15'-6¼"	15'-6¼"	----------
L	5'-11"	7'-2"	6'-10½"	8'-1½"	9'-1"	8'-4¼"	9'-2¼"	10'-2"	11'-4"	12'-10"**
M	12"	12"	15¼"	15¼"	15¼"	----------	----------	----------	----------	----------
N	2'-9¼"	2'-9¼"	3'-2¼"	3'-2¼"	3'-2¼"	3'-5¾"	3'-5¾"	3'-5¾"	3'-5¾"	3'-5¾"
O	7'-3¾"	7'-3¾"	8'-4¼"	8'-4¼"	8'-4¼"	9'-5"	9'-5"	9'-5"	9'-5"	8'-4"
Rated HP Continuous	500	600	575	690	805	1000	1200	1400	1600	2000 (Net)
Rated Speed	400	400	300	300	300	300	300	300	300	300

The built-in scavenging pump is omitted on the 10-cylinder, 16 x 20 engine.
**Center of gravity to be from center line of No. 1 cylinder.

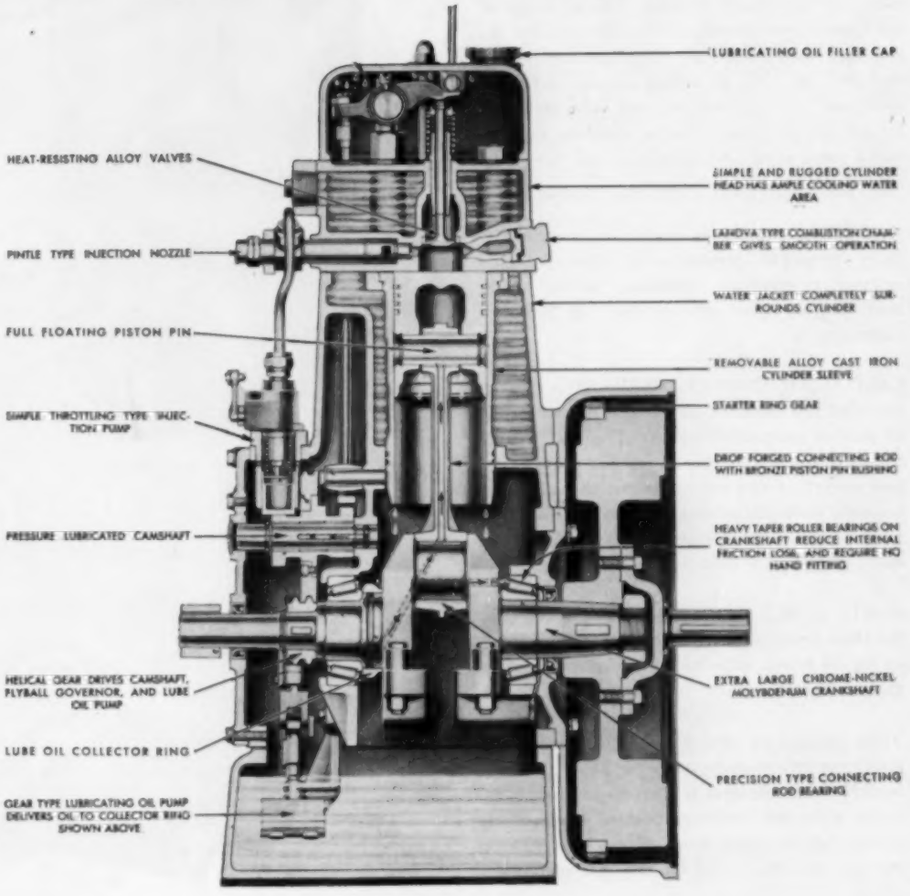
FAIRBANKS-MORSE ONE- AND TWO-CYLINDER MODEL 45

The single-cylinder vertical engine has 3¼"x4" cylinder developing 5¼ hp. and a 4⅛"x4½" cylinder developing 10½ hp., both engines operating at 1800 rpm. In addition, the two-cylinder unit, having a bore of 4⅛" and a stroke of 5¼" develops 32 hp. for stationary or marine application at 1800 rpm. It is also offered as a power unit, with or without clutch power take-off, also as AC or DC Generating Set. A small Diesel engine with many of the features of larger engines makes the Model 45 practical for general service such as powering an electric generator, pumping water, driving tools and auxiliary standby service.

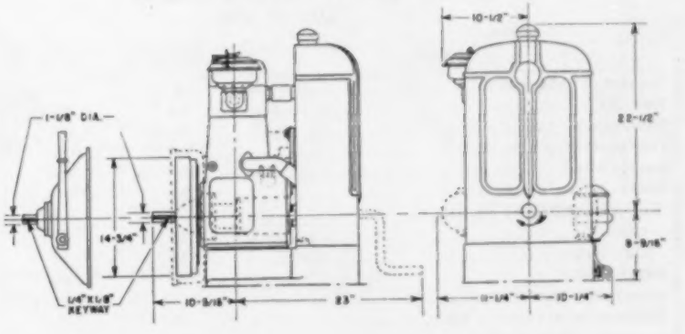
The two cylinder unit is offered both as a light weight engine under standard construction, and in the ULTRA LIGHT WEIGHT engine for special applications. All units equipped with pressure lubrication to provide longer life and lower maintenance.

FLYBALL TYPE GOVERNOR has an outside adjustment so that minor speed changes can be readily and quickly made while the engine is in operation. With a given setting the governor automatically maintains speed regulation for any load within the range of engine rating which makes it particularly adaptable for direct connecting to a generator.

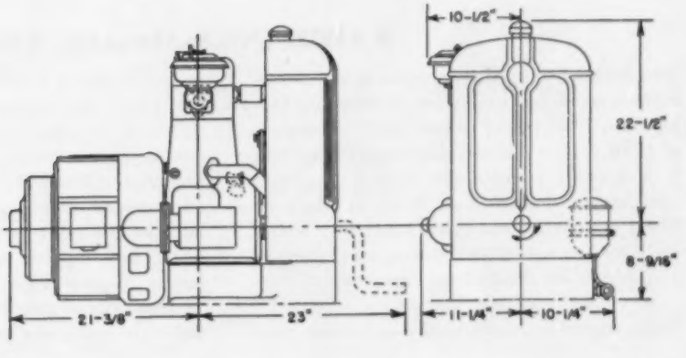
REMOVABLE CYLINDER SLEEVE is cast from a special mixture of close grained cast iron, is honed to accurate dimensions. This design permits easy removal of the cylinder liner for inspection and maintenance. This feature also provides an inexpensive method of replacement and eliminates the necessity for purchasing a complete new cylinder block as well as the expense of disassembling and reassembling the engine should replacement be necessary.


LUBRICATING OIL FILLER CAP
HEAT-RESISTING ALLOY VALVES
SIMPLE AND RUGGED CYLINDER HEAD HAS AMPLE COOLING WATER AREA
PINTLE TYPE INJECTION NOZZLE
LANOVA TYPE COMBUSTION CHAMBER GIVES SMOOTH OPERATION
WATER JACKET COMPLETELY SURROUNDS CYLINDER
FULL FLOATING PISTON PIN
REMOVABLE ALLOY CAST IRON CYLINDER SLEEVE
STARTER RING GEAR
SIMPLE THROTTLING TYPE INJECTION PUMP
DROP FORGED CONNECTING ROD WITH BRONZE PISTON PIN BUSHING
PRESSURE LUBRICATED CAMSHAFT
HEAVY TAPER ROLLER BEARINGS ON CRANKSHAFT REDUCE INTERNAL FRICTION LOSS, AND REQUIRE NO HAND FITTING
HELICAL GEAR DRIVES CAMSHAFT, FLYBALL GOVERNOR, AND LUBE OIL PUMP
EXTRA LARGE CHROME-NICKEL MOLYBDENUM CRANKSHAFT
LUBE OIL COLLECTOR RING
PRECISION TYPE CONNECTING ROD BEARING
GEAR TYPE LUBRICATING OIL PUMP DELIVERS OIL TO COLLECTOR RING SHOWN ABOVE

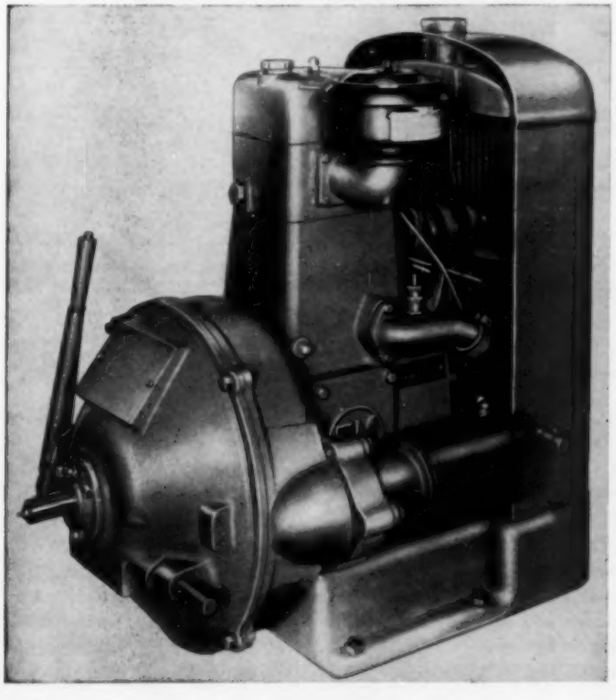
Principal Dimensions of Model 45C3⅛ Power Units with Radiator.



Principal Dimensions of Model 45C3⅛ Generating Set.



Model 45C3⅛ diesel power unit with clutch, radiator and electric starting.



REMOVABLE CYLINDER HEAD contains the valve and combustion chamber. Unique design of the Lanova type combustion chamber produces the necessary turbulence for proper mixing of the fuel and air, thus providing smooth and quiet operation. The enclosed overhead valve and valve mechanism are accessible after removing one nut and a small cover. Adjustment of the valve stem clearance is then a simple matter.

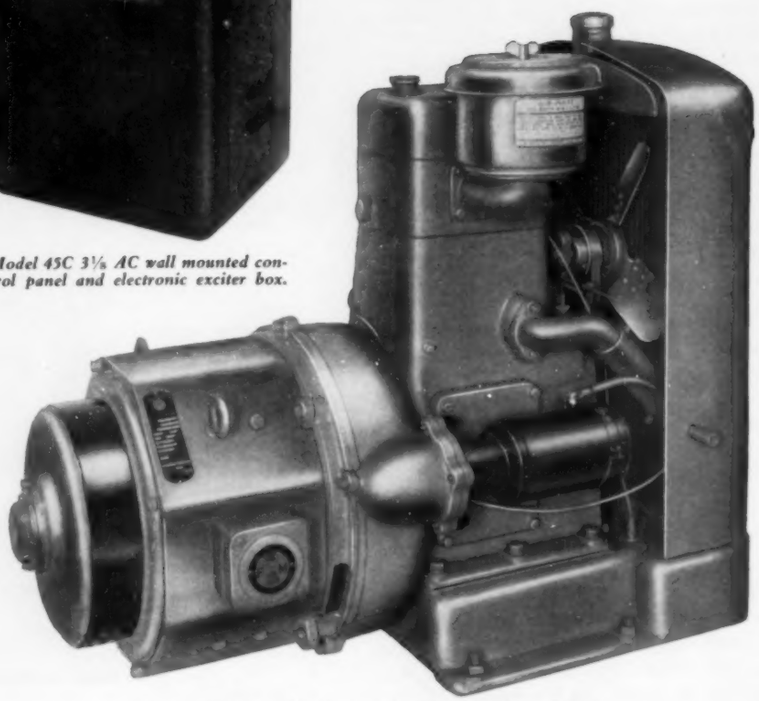
INJECTION PUMP is simple in construction, easily accessible, automatically lubricated and designed to eliminate "dribbling" at the nozzle, thus assuring good combustion and low fuel consumption.

CAST ALLOY IRON CRANKSHAFT is counterbalanced and mounted on Timken roller bearings to provide exceptional rigidity. This construction together with the aluminum pistons provides engine operation with a minimum of vibration. The large size crankpin bearing is of the precision type, steel backed babbitt lined. These bearings are easily inspected or replaced.

PARTS EASILY ACCESSIBLE. The removal of the front cover gives access to the governor, lubricating oil pump, valve and injection pump operating mechanism.

These engines are offered with complete radiator cooling or heat exchanger cooling. Electric starting with 12 volt equipment is offered optionally. Generator units are available in three types: direct current lighting plant, direct current battery charging sets, and alternating current light plants.

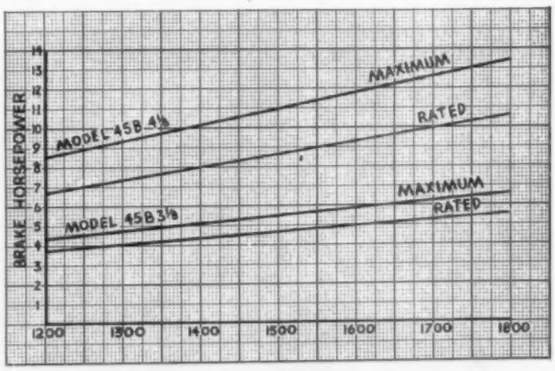
Model 45C 3⅛ AC wall mounted control panel and electronic exciter box.



Fairbanks-Morse Model 45C 3⅛ 3-kw. AC generating set.

GENERAL SPECIFICATIONS
MODEL 45C

MODEL	45C3⅛	45C4⅛	45C⅛-2
Number of Cylinders	1	1	2
Bore (In.)	3⅛	4⅛	4⅛
Stroke (In.)	4	4½	5¼
Displacement (Cu. In.)	30.7	60.14	140.3
Rated—RPM	1800	1800	1800
Rated—HP	5¼	10½	32
Torque at 1800 RPM (Ft. Lbs.)			
Rated	15	30	73
Maximum	19	38	84
Rated—BMEP	80	80	98
Compression Ratio	15.5 to 1	15.5 to 1	16 to 1
Lubricating Oil Capacity (Qt.)	6	7	8½
Number of Main Bearings	2	2	2
Size of Main Bearings (In.)	2 x 1⅞	2½ x 1½	3 x 2
Crankpin Size (In.)	2 x 1¼	2⅜ x 2¼	2⅜ x 2¼



Speed and horsepower characteristics for the 5¼ hp., 10½ hp. models of the 45C

FAIRBANKS-MORSE TWO-CYCLE MODEL 49B4 1/2

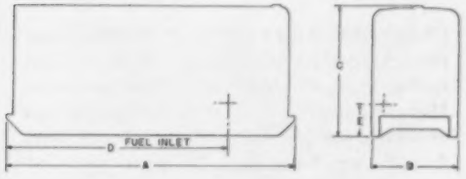
The Model 49B4½ Diesel engine is a two-cycle medium speed, lightweight, full Diesel engine having a 4½" bore by 5½" stroke, with displacement of 87 cu. in. per cylinder. This engine is built in 2, 3, 4 and 6 cylinder sizes, with a continuous rated output of from 58 to 180 hp. at 1800 rpm. These conservative ratings are based on a BMEP of 76 lbs. per square inch. Intermittent ratings at 15% higher are standard on these units.

These engines are easily adaptable, compact power units featuring simplified, practical design with low weight per horsepower. All parts are designed to withstand loads beyond any that may ever be experienced, even in severe applications. Conservative horsepower offers more reserve power when needed—adds to engine life. These units are built on the 2-cycle principle, which produces a smooth flow of power, higher efficiency and higher torque (lugging power). Simple design and conveniently located accessories save time in both normal maintenance and repairs. Compact, and light in weight, these engines are capable of operating at relatively high speed and are able to operate efficiently under conditions of both varying speeds and loads.

CYLINDER HEAD, LINER AND WATER JACKET assembly consists of a special cast iron liner with compound ground air inlet ports to give a radial and upward flow to the scavenging air. High degree of turbulence together with complete uniflow scavenging, assures efficiency and

6-cylinder Fairbanks-Morse 75 kw. Model 49B4½ Generating Set.

economy of operation. The alloy cast iron cylinder head contains a single, large exhaust valve which is completely surrounded by large cooling water passages. The cylinder liner has a full length integral water jacket for maximum cooling. The cylinder head and liner are assembled as a single unit, but component parts can be easily replaced in the field and are interchangeable between engines having a different number of cylinders. This unitized assembly reduces inspection and maintenance time.



PRINCIPAL DIMENSIONS

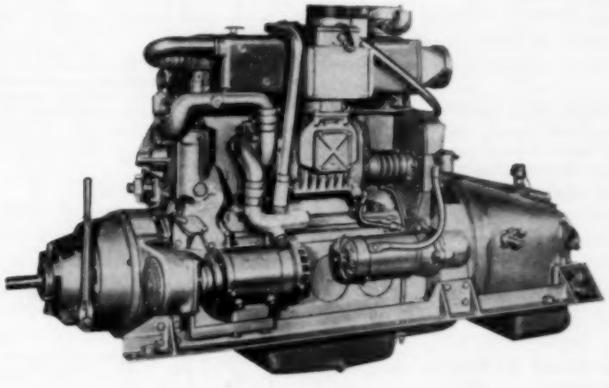
Model	49B4½ GENERATING SET			
KW Rating	20-25-30	40-50	60-75-100-125	
A	85	99	109	118
B†	32	32	32	32
C*	50	50	50	50
D	61	81	88	80
E	23	23	23	23

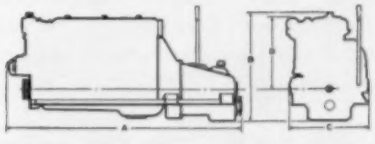
†less air cleaner.
*less muffler.

SHIPPING DATA

Model	49B4½ GENERATING SET								
KW Rating	20	25	30	40	50	60	75	100	125
Total Wt. (Basic)	2200	2250	2400	4000	4050	4850	5000	5200	5400
Shpg. Wt. (Domestic)	2320	2370	2550	4150	4200	4850	5200	5400	5600
Shpg. Wt. (Export)	2700	2750	2900	4600	4700	5400	5700	5900	6100
Cu. Ft. boxed (Export)	140	140	140	158	175	193	193	193	201

3-cylinder Fairbanks-Morse Model 49B4½ marine engine with reduction gears and front PTO.





PRINCIPAL DIMENSIONS

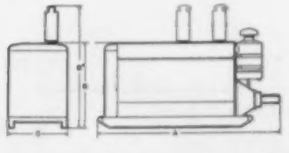
Model	49B4½–MARINE			
Number of Cylinders	2	3	4	6
A	55"	65"	75 5/16"	88 5/16"
B	38"	38"	38"	38"
C	28"	28"	28"	28"
D	27¼"	27¼"	27¼"	27¼"

SHIPPING DATA

Model	49B4½–MARINE			
Number of Cylinders	2	3	4	6
Total Wt. (Basic Engine)	1350	1775	2100	2700
Shpg. Wt. (Domestic)	1620	2130	2520	3240
Shpg. Wt. (Export)	1760	2300	2730	3500
Cu.Ft. boxed for Export	79	98	114	180

LUBRICATION SYSTEM supplies full pressure lubrication to all bearings and moving parts by a positive gear type pump mounted at the bottom of the crankcase. Oil pressure is accurately regulated by a spring-loaded relief valve. A full-flow strainer and filter are located on the side of the crankcase where they are easily accessible for servicing.

COOLING SYSTEM consists of a radiator, fan and centrifugal circulating water pump. Warm-up



SPECIFICATIONS

Number of Cylinders	2	3	4	6
Bore and Stroke—inches	4.5 x 5.5	4.5 x 5.5	4.5 x 5.5	4.5 x 5.5
Total Displacement—cu. inches	175	261	348	522
Compression Ratio	16 to 1	16 to 1	16 to 1	16 to 1
Continuous H. P. at 1800 RPM*	58	90	126	180
NBFU* Rating—H. P. at 1800 RPM		110	150	230
Max. Torque at RPM	243 @ 1400	401 @ 1300	600 @ 1350	825 @ 1300

NBFU approved units in 3, 4 and 6 cyl. engines are now available.
Intermittent rating is 15% above continuous ratings shown.
*These are ratings available for fire pump service as approved by the National Board of Fire Underwriters.

PRINCIPAL DIMENSIONS

Model	49B4½–STATIONARY			
Number of Cylinders	2	3	4	6
A	56"	68¼"	77"	98¼"
B	46"	46¼"	47"	47"
B†	52"	52"	60"	68¼"
C	32"	32"	32"	32"

SHIPPING DATA

Model	49B4½–STATIONARY			
Number of Cylinders	2	3	4	6
Total Wt. (Basic Engine)	1400	1800	2200	2700
Shpg. Wt. (Domestic)	1680	2160	2640	3240
Shpg. Wt. (Export)	1820	2340	2760	3500
Cu.Ft. boxed for Export	79	98	114	180

time is reduced, and proper operating temperatures are assured by an automatic thermostatic valve.

EXHAUST VALVE—a single valve per cylinder—is made of heat-resisting alloy steel, and is operated from the camshaft through a push-rod and rocker arm. The entire cylinder block of the Model 49 Diesel engine is made of aluminum alloy. This automatically provides more valve clearance when the engine is hot—an extremely important safety feature that completely eliminates burned exhaust valves due to insufficient clearance.

CRANKCASE AND CYLINDER BLOCK is one-piece, lightweight, high strength aluminum alloy casting. Heavy ribs insure rigidity and permanent alignment of parts, while the individual cylinder assemblies are inserted into the cylinder block from the top. Large inspection ports oposite cylinders give full access to the crankpins and main bearings. This important feature eliminates the necessity for dropping the oil pan for routine inspection or maintenance.

STARTING SYSTEM ON the 2 and 3-cylinder engines is a standard 12-volt system. A 24-volt system is used on the 4 and 6-cylinder units. An air starting motor, as well as a cold weather starting aid, may be employed if necessary.

FUEL INJECTION SYSTEM is built around the Roosa Master pump. It provides easier starting, better engine response and accurate metering of supply of fuel to each cylinder. It includes a built-in transfer pump and a sensitive governor. Fuel filters are easily accessible for cleaning, while the fuel injectors contain only a single large spray hole to eliminate the danger of clogging.

CRANKSHAFT AND CAMSHAFT are of special alloy steel which is forged and heat treated. Actuating cam for the exhaust valve and fuel injection pump is integral with the shaft and is hardened and precision ground. All shaft bearings are of aluminum alloy. All shaft bearings, linkage and helical timing gears are arranged for full pressure lubrication.

BLOWER is a postive displacement, Roots type. It is gear driven from the timing gear train. Two blowers are mounted on the 6-cylinder engines, with the remaining engines using only a single blower. Blower capacity is carefully calculated to provide a plentiful supply of air to the uniflow scavenging system, thus assuring clean combustion and economical operation.

FAIRBANKS-MORSE FOUR-CYCLE MODEL 48

The Model 48 Diesel engine is built in 2 and 4-cylinder units of, from 13.5 to 51 hp. at 1800 rpm. for marine, stationary, and generating service.

For industrial service, the engines are fitted with power take-off clutch and stub shaft. Generator units have generators direct connected and attached to the flywheel housing, supported by the sub-base in the larger sizes. Close governing, to within 3½%, permits parallel operation of alternating current units.

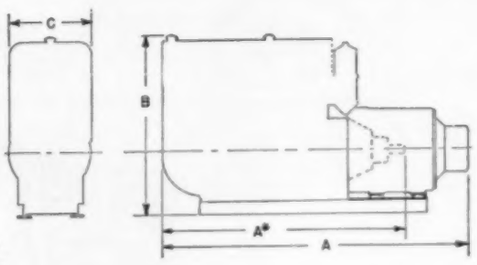
For marine propulsion service, a wide assortment of reverse reduction gears is available to permit use of the most efficient propeller for any given hull design. These gears bolt directly to the flywheel housing, forming an integral, enclosed part of the engine unit.

The 1 and 2-cylinder engines are available as marine auxiliaries. The engine, generator, compressor and centrifugal fire and bilge pump can be mounted on a common sub-base to form a compact unit.

THE GROSS RATING is the maximum gross power rating for gross use. The fan is not included and correction has been made for temperature and atmospheric pressure. Fuel oil used is 19,000 Btu. per pound.

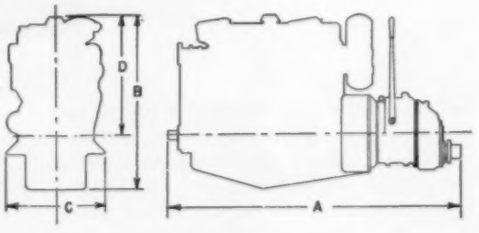
THE INTERMITTENT NET RATING is the net power available for shovels, cranes, saws, scrapers, etc. This rating is made under average conditions of temperature and pressure (500 ft. Altitude and 60° to 80° F.) with fuel oil of average quality. All accessories operating.

Line drawing of Model 48A power unit or generating set.



THE CONTINUOUS NET RATING is net power available for continuous service. This rating is made under average conditions of temperature and pressure (500 ft. Altitude and 60° to 80°F.) with fuel oil of average quality. All accessories operating.

Line drawing of Model 48A Marine Diesel.



PRINCIPAL DIMENSIONS

Model 48A Engines	A	A*	B	C	D
Marine:					
48A 3½—2 Cyl.	31 1/16"		29"	18"	19"
48A 3½—4 Cyl.	41½"		29"	18"	19"
48A 4½—4 Cyl.	57"		46"	21½"	35½"
Power Unit:					
48A 3½—2 Cyl.		36¼"	30¾"	19"	
48A 3½—4 Cyl.		45¾"	30¾"	19"	
48A 4½—4 Cyl.		60"	46"	21½"	
Generating Set.					
5 and 7½ kw	52"		38¼"	21"	
10 and 15 kw	65"		38¼"	21"	
20 and 25 kw	76½"		46"	21¼"	
30 and 35 kw	82¾"		46"	21¼"	

MODEL 48A ENGINE & GENERATING SET RATINGS

Model	Bore	St'ke	No. Cyl	RPM	Piston Disp.	Cont. HP	Inter. HP	Generating Set Ratings KW 1800 RPM
48AS3½	3½	4	2	1800	76.8	13.5	15.0	7.5
48AS3½	3½	4	4	1800	143	28	31	15
48AS4½	4½	5	4	1800	318.0	51.4	56.2	35.0

GENERAL MOTORS

CLEVELAND DIESEL ENGINE DIVISION

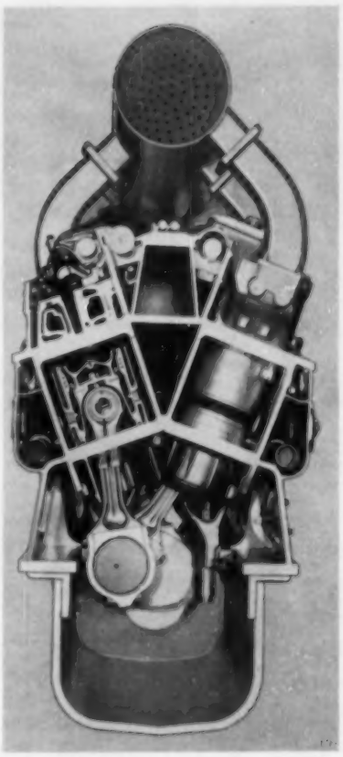
MODEL 498 TURBOCHARGED TWO-CYCLE DIESEL

This General Motors Model 498 turbocharged diesel engine is particularly designed to meet the increased demand for greater horsepower by the marine and industrial markets. It can be supplied with direct-connected generator for electric drive or with a clutch-reverse-reduction gear for direct drive. Sizes range from 1400 to 2800 hp. The features of this engine are lower initial and installation costs per horsepower, fewer working parts per installed horsepower, lower operating costs because of higher efficiency, and much lower maintenance expense per horsepower.

The engine has a practically flat fuel-rate curve from 50% - 100% at any operating speed. By arranging the exhaust-driven compressor in series with the engine-driven positive displacement blower, the acceleration is exceptionally good with a clear exhaust.

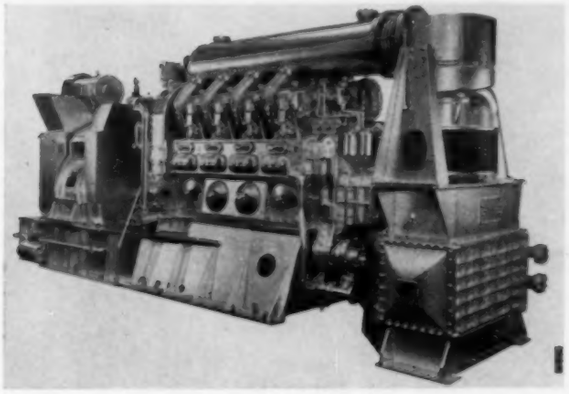
Accessibility of engine parts for inspection or removal, with improved location of fuel and lube oil piping, permits ready servicing of cylinder heads, pistons and liners. The crankcase is designed with a generous factor of safety. All stress-welds are designed for continuous submerged arc welding, and the crankcase itself is stress-relieved and shot-peened to reduce stress concentrations. Removable wear rings between cylinder liners and the crankcase eliminate "wear-out" of crankcase during the life of the engine. Furthermore, no coolant water is in contact with the crankcase, which eliminates crankcase corrosion. Provision has been made for cylinder head and main bearing bolts, thereby eliminating studs. Crankpins and main bearing journals, which are induction hardened to approximately 50 Rockwell "C", are of adequate size, assuring reasonable bearing pressure. The use of steel-back, lead-bronze bearing shells with a lead-tin overlay makes crankshaft wear negligible. The camshaft, camshaft bearings, rocker arms, rocker-arm bearings and rollers are of ample size, assuring rigidity and durability.

Separate piston cooling by oil spray jets assures that low piston temperatures are maintained. Through drilled connecting rods, the wrist pins and bearings are lubricated by force-feed lubrication. The wrist pin and bushings are of ample size to withstand the increased firing pressure of turbocharging, and the connecting rod is of rigid design with a strap construction at the crankpin end for easy removal. A hardened-steel sleeve is used in the connecting-rod eye to prevent wear on the rod proper. A floating-type piston is used with Ferrox-filled compression rings to increase piston ring and liner life, and to obtain complete piston symmetry and, therefore, uniform thermal stress distribution. The cooling passages in the cylinder heads have been designed to insure symmetrical water flow through the heads and liners. The exhaust valves operate at a low temperature as a result of the tremendous air-cooling effect due to turbocharging.

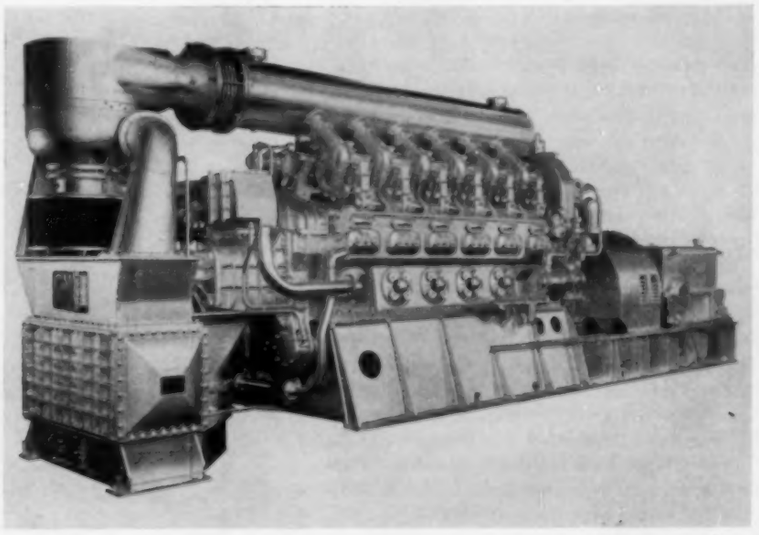


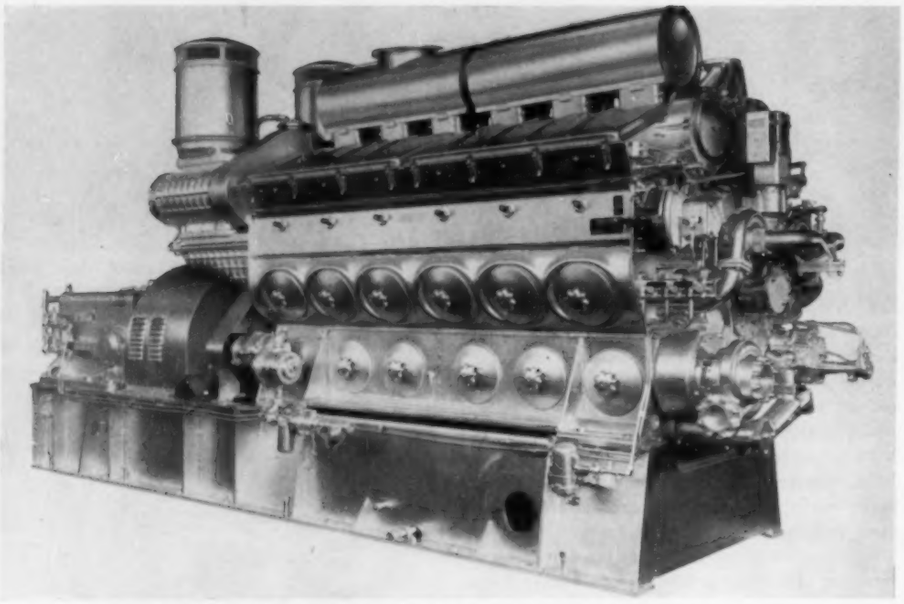
Cross section of Model 498 turbocharged diesel engine.

General Motors Model 8-498 V-type turbocharged generator set.



General Motors Model 16-498 V-type turbocharged marine propulsion engine.





General Motors Model 12-567C V-type marine propulsion engine.

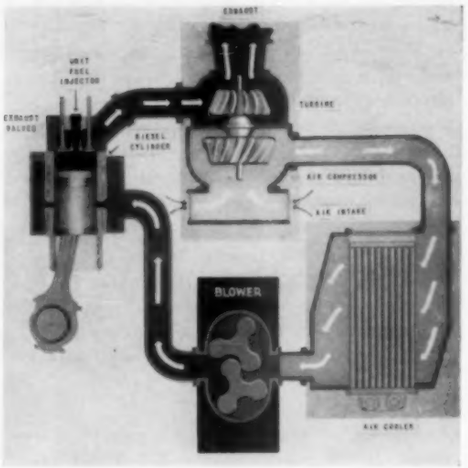
TWO-CYCLE DIESEL

MODEL 567C

The General Motors Model 567C is a V-type two-cycle diesel engine manufactured by the Electro-Motive Division. The engines are modified and adapted for marine application by the Cleveland Diesel Engine Division. Main propulsion sets in either direct or diesel-electric drive are available. Generator units are built for either shipboard or stationary power supply. Detail description of the Model 567C engine will be found elsewhere in this book under the listing of the Electro-Motive Division.

ENGINE SPECIFICATION CHART

Engine Model	Bore and Stroke	NOMINAL		No. Cyls.	Dis-placement In.	Eng. Wt. Lbs.	Engine Dimensions	
		Rated BHP	Output RPM				Width Ft.	Length O. A. Ft.
8-498	8.75 x 10.5	1400	850	8	5,051	28,600	5' 4"	12' 8"
12-498	8.75 x 10.5	2100	850	12	7,576	39,000	5' 4"	16' 1"
16-498	8.75 x 10.5	2800	850	16	10,102	46,000	5' 6"	19' 6"
8-567C	8.5 x 10	800	800	8	4,540	19,500	5' 2"	11' 6"
12-567C	8.5 x 10	1200	800	12	6,809	27,800	5' 5"	14' 7"
16-567C	8.5 x 10	1600	800	16	9,079	33,900	5' 2"	17' 10"
16-358	12.5 x 14.5	3500	600	16	28,470	86,500	10' 6"	16' 5"
6-268A	6.5 x 7	340	1200	6	1,394	7,000	3' 5"	8' 1"
8-268A	6.5 x 7	450	1200	8	1,858	8,600	3' 5"	9' 9"



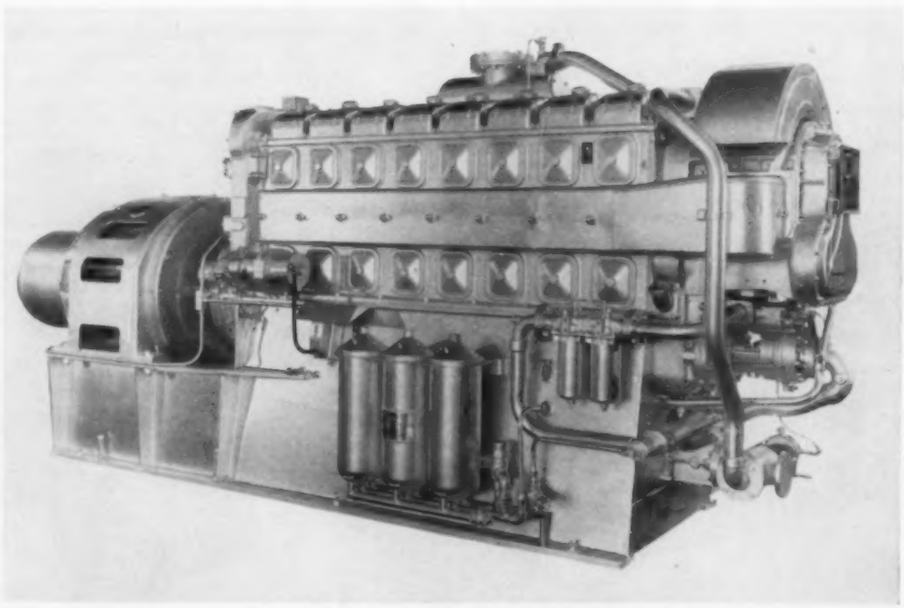
Schematic diagram of turbocharged diesel engine.

MODEL 268A TWO CYCLE

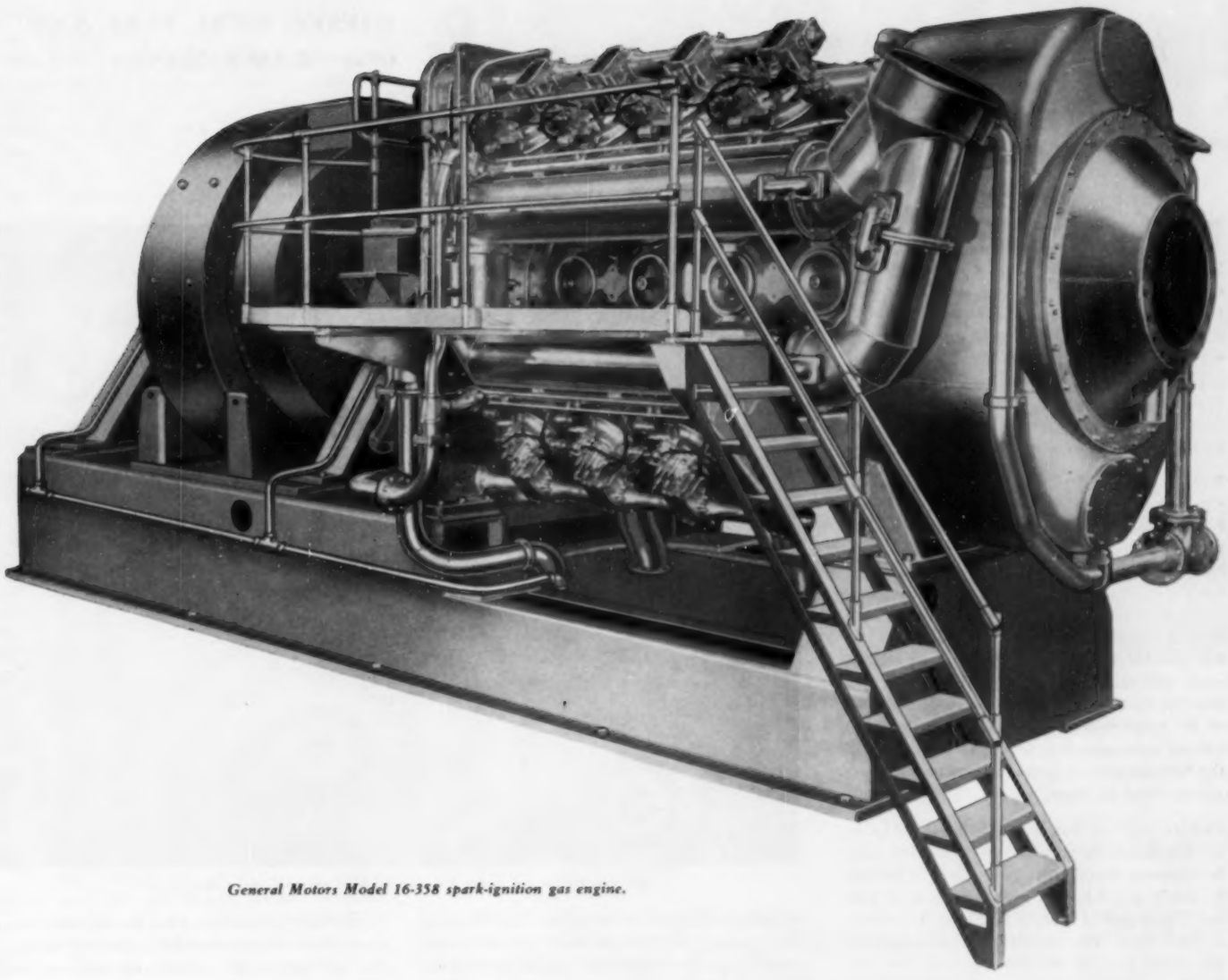
THESE two-cycle Model 268A diesel engine generator sets are built as complete units, ready for installation.

The crankcase is a one-piece, fusion-welded unit. The crankshaft is a chrome-nickel-molybdenum steel forging. The piston is made of strong, close-grained alloy cast iron. The connecting rods are drop-forged and heat-treated alloy steel. Each cylinder head is fitted with four exhaust valves, the unit injector, the rocker lever assembly, an over-speed injector lock, and the cylinder test valve. The four exhaust valves are made of special heat-resisting alloy steel. The engine is equipped with replaceable wet-type liners.

The accessory drive is located between the end of the crankcase and the blower, and consists of a train of helical gears. All bearings and gears are under pressure lubrication. The camshaft is of the one-piece type with integral case-hardened cams and bearings. The engine speed is controlled by a self-contained hydraulic governor.

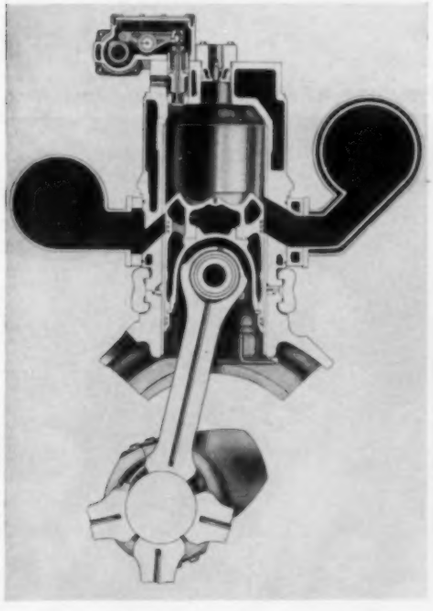


General Motors Model 8-268A in-line generator set.



General Motors Model 16-358 spark-ignition gas engine.

Cross section of Model 16-358 gas engine.



MODEL 16-358 TWO CYCLE GAS ENGINE

This engine is a spark-ignited, loop-scavenged, two—cycle gas engine, rated 3500 hp at 600 rpm. It is built with engine-driven scavenging air compressor and attached engine accessories in addition to generator applications, it can be direct-connected to standard speed increasers or reduction gears, and will drive either pumps or centrifugal compressors.

The engine is arranged in four rows of four cylinders each, with 90° spacing between the banks. The connecting rods are of the slipper type. The full-floating, cast-iron pistons are oil-cooled by spray nozzles and also through drilled connecting rods. The barrel-shaped crankcase is built up entirely of steel forgings which are welded together. The crankshaft is counterweighted to give perfect engine balance.

Air is supplied to the engine through four intake manifolds by a centrifugal type air compressor mounted at the front end of the engine. There are nine air inlet ports, and five exhaust ports in each cylinder.

The cylinders are mounted on the crankcase by means of clamping rings made in two halves for easy assembly and removal in service. Water pumps, lubricaing oil pumps, governors and timers are driven from the rear end of the engine. A 1½″ diameter gas inlet valve is located in the top of the cylinder. One water-cooled spark-plug is centrally mounted in the cylinder.

The main bearings are designed so they can be removed without disturbing the crankshaft. The main bearing carrier is made in three cast-steel sections, which are bolted together at the split lines and are held in position in the crankcase by retractable dowels.

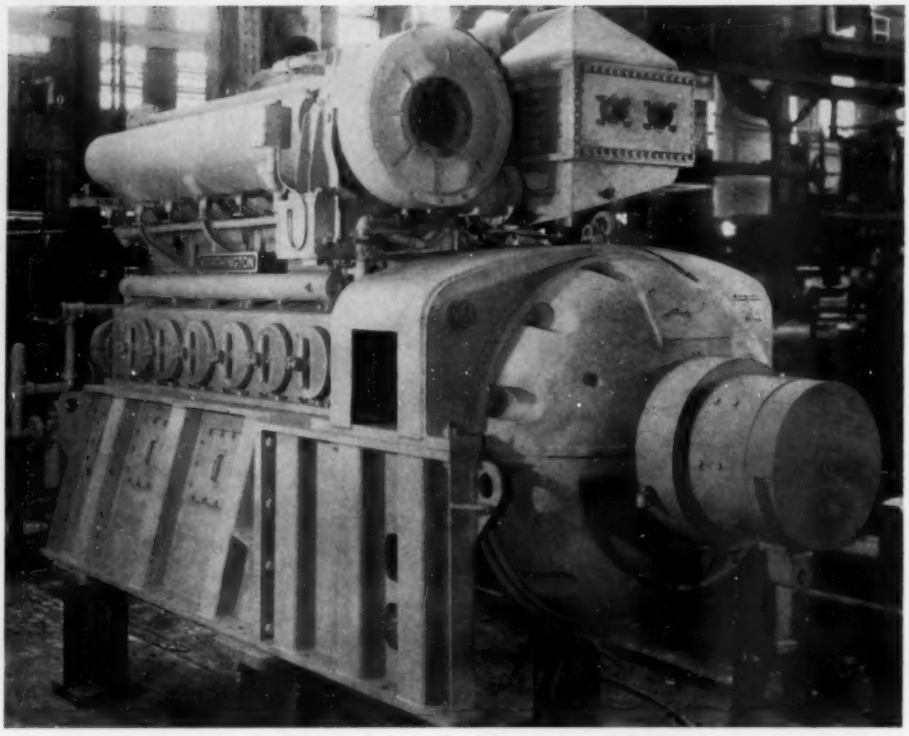
WORTHINGTON

DIESEL, DUAL FUEL AND GAS ENGINES

HIGH power performance is yours with all Worthington diesels because each type has been engineered especially for its power range and service application. Worthington offers a complete line of heavy duty diesel engines. There are six different types and 30 models of turbocharged or non-turbocharged engines to meet almost any application requirement. Available in ratings from 500-5000 horsepower, all models can be supplied as oil or dual fuel diesels, and are convertible to spark ignition gas or tri power engines.

BASE is of cast iron or welded steel of rigid design with heavy transverse supports for each main bearing. A deep sump is provided under a strainer plate to act as a lubricating oil reservoir. Wide ledges provide generous support with low unit loading on concrete or other types of foundations. Foundation bolts are located opposite each main bearing with deep lugs as an integral part of the side member sections of the base. Outer edge is made with raised lip to prevent spilled oil from affecting the foundation. In some models, rigidity of the frame is further increased by heavy steel tension bolts extending from near the bottom of the base adjacent to main bearings to the upper midsection of the frame.

FRAME is of cast iron or welded steel of substantial box-shaped design with heavy transverse members between the cylinders. It is secured to the base by closely spaced rows of studs to prevent oil leakage. Upper part of frame is bored for the separate cylinder liners. The vertical transverse sections in the upper part of the frame provide not only sturdy cross bracing but form separate compartments around each cylinder liner so that there is a rapid and controlled circulation of the jacket cooling water. Large lightweight doors are fitted to provide complete access to the main bearings and running gear. Separate covers enclose the fuel injection pump compartment on the front of the engine.

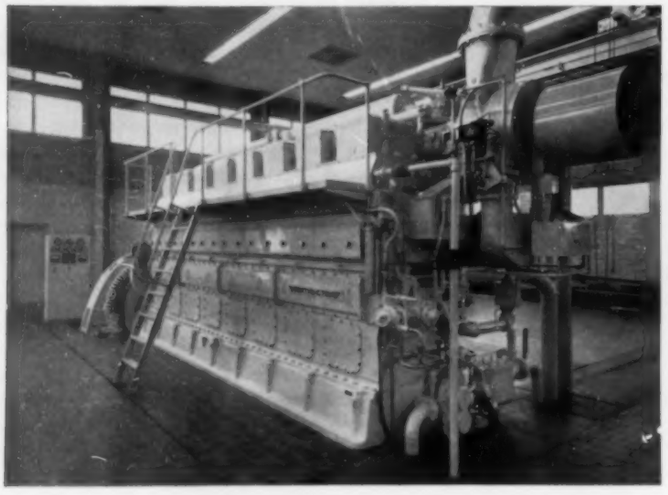


SW 9 turbocharged engine for modern Western municipal power plant.

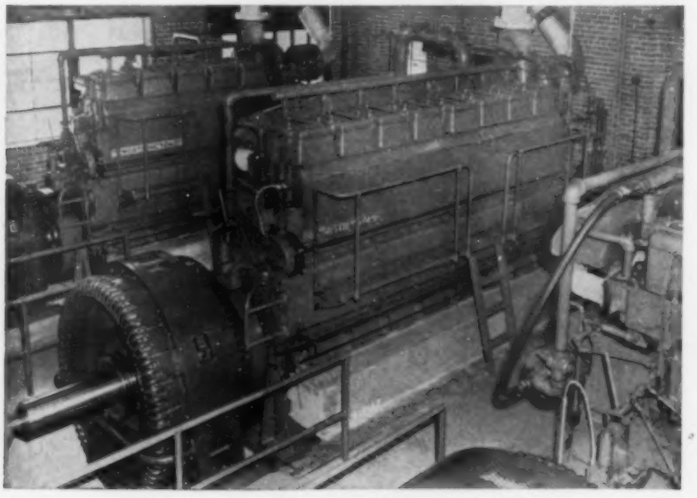
CYLINDER LINERS are cast of special alloy iron and are completely symmetrical assuring uniform heat transfer and lack of distortion due to heat. Liners have inside bore carefully honed. They are secured in top of frame on metal to metal joint, and are free to expand although guided at lower end.

CRANKSHAFT is of open hearth steel, forged in

Worthington type SEHGO turbocharged dual fuel diesel engine in a modern municipal power plant.



Three type SDHGO dual fuel diesel engines in a Mid-Western Municipal Power Plant.



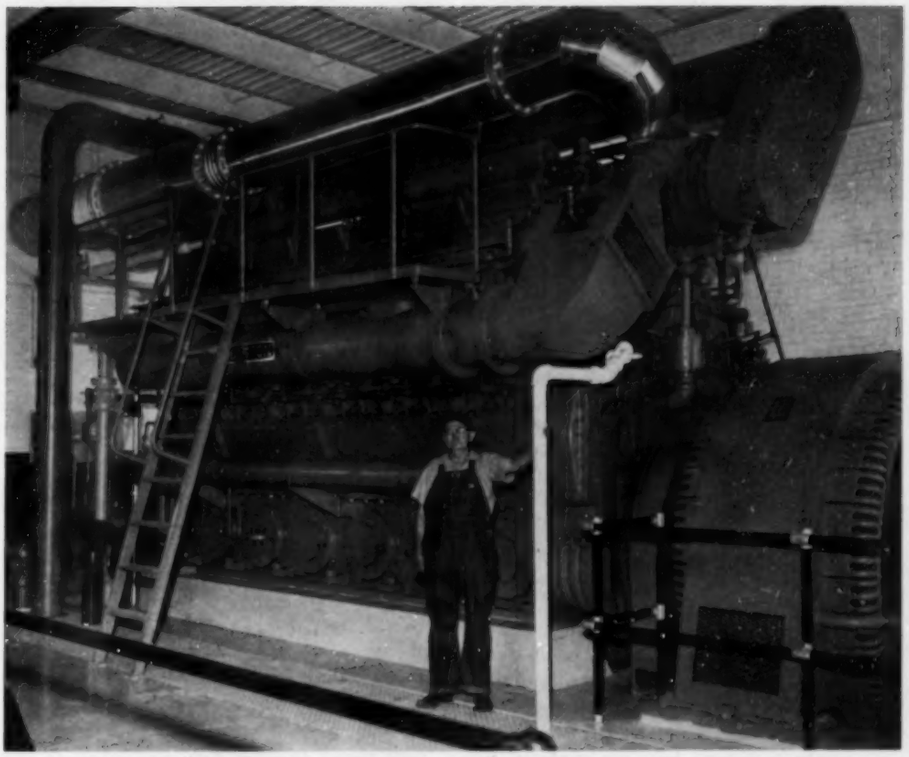
one piece. Heat-treated to give most suitable physical characteristics, it is finished all over with main journal and crankpin bearing surfaces polished. Alignment bearing is provided to prevent endwise motion. Crankshaft is drilled to carry lubricating oil from main journals to crankpin bearings.

MAIN BEARINGS are concentric shells lined with centrifugally cast anti-friction bearing metal. Bottom shell is carefully fitted to its seat in the base, and bearing cap holds top shell. Cast steel bearing caps are held down to provide support for overhung masses or an extra bearing is fitted at the flywheel end as in the EH model.

CONNECTING RODS are of drop forged special alloy steel with I-beam section. Crankpin ends are fitted with concentric bearing shells similar to main bearings. Four bolts are used to hold boxes or caps. Wrist pin ends are forged solid and fitted with solid bronze bearing bushings. Rods are rifle drilled their length to carry lubricating oil to the wrist pin bearing and for cooling the piston.

PISTONS are of special iron alloy, although aluminum alloy pistons are used in some cases for the higher speed ratings. Pistons are carefully ground to size and fitted with a suitable number of compression rings and oil control rings. The open type combustion chamber is formed in the top surface of the piston, and the underside of the crown is oil cooled. Wrist pins are of floating type, forged of high grade steel, hardened and ground to size and for fine running fit. They are liberally proportioned and held in place by special retaining rings.

CYLINDER HEADS are cast of a special alloy of nickel iron. They are designed for best metal distribution and adequate cooling. The main structure of the head is of inverted conical shape to produce maximum strength and greatest freedom from expansion strains. Seating of head on cylinder liner is made pressure tight without a gasket. Each head has an intake and an exhaust valve with the fuel injection valve in between them in the center of the head, an air starting valve, and an indicator connection. Cast iron enclosure for the valves and the valve gear supports the fulcrum for the valve rockers and is bolted to the top of the head. An easily removable cover is secured to the top of this enclosure.

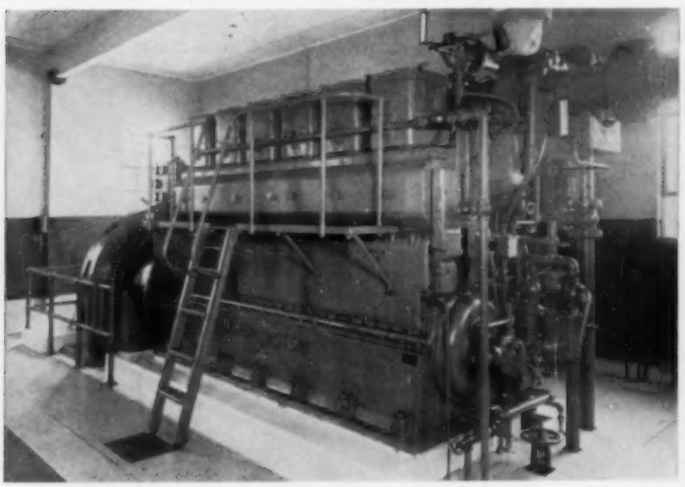


SW 14 turbocharged power source for Western municipal power plant.

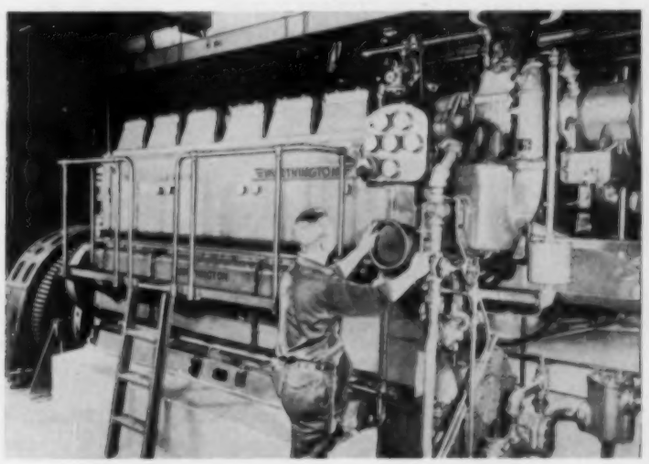
VALVES, INTAKE AND EXHAUST, are made of materials best suited to their individual operating conditions. Valves have large stems fitted into long well-cooled guides made of wear-resisting cast iron. Two valve springs for each valve, one is mounted inside of the other. Baffles cast into the cylinder heads direct the flow of cooling water to the valve areas in the head that are subjected to the highest temperatures. Valves seat directly on the head, and the good cooling assures long valve life and extended periods between grindings. Valves are operated by rockers and push rods from the camshaft in the crankcase.

AIR STARTING SYSTEM consists of an air distributor driven from the free end of camshaft and individual piston operated pilot valves in each cylinder head. One lever-actuated starting air valve and a standard shut-off valve is connected to the starting air manifolding serving individual cylinder heads.

Worthington type SCC-6 turbocharged Diesel in a Midwestern power plant.



Worthington Type SDH-6 turbocharged heavy duty diesel engine supplying stand-by power for a large paper manufacturing company.



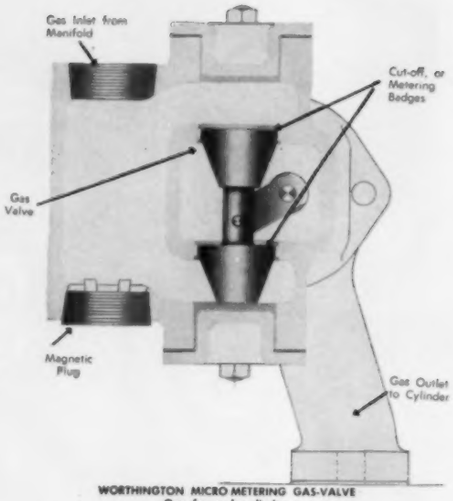
CAMSHAFT is of high grade steel fitted with adjustable fuel pump cams. All other cams are integral with the shaft. All cams are hardened and ground. Camshaft is mounted in adjustable bearings, set on brackets which are cast integral with the frame. It is driven by the crankshaft through an adjustably-mounted idler gear. Angle-cut spur gears are used throughout. All bearings and valve gear are totally enclosed and pressure-lubricated. On most models, final adjustment of the camshaft relative to the valve and injection timing is by infinite precision between the camshaft and camshaft drive gear adjustment.

FUEL INJECTION SYSTEM is of pump-timed type with individual pumps mounted at each cylinder just above the camshaft. Spray valves in cylinder heads are of automatic plunger type with multiple hole nozzles which insure correct fuel oil distribution in the combustion chamber, and efficient combustion. All pumps, fuel injection valves, and the connecting high pressure fuel lines are fully interchangeable. Materials used in pumps and spray valves are special alloy steels which resist corrosion. Efficient strainers are provided at most suitable points in fuel line to reduce possibility of scoring of plungers due to fine particles of grit. Fuel injection pumps are mounted in an enclosed chamber, built into the side of the frame. They are completely isolated from the crankcase, yet fully accessible. Fuel cannot leak into the crankcase, nor lubricating oil vapor into this chamber. Drains carry away any fuel oil leakage.

Control racks on the individual fuel pumps are connected to the governor by simple direct linkage floated in bronze bushed bearings giving sensitive, fast speed control. Linkage to each pump is arranged with a spring loaded disengaging mechanism set to cut out the individual pumps if for any reason the rack becomes inoperative. It is a safeguard against overspeed when the load is decreased, and against a shut down when the load is increased, should any fuel pump become damaged in any way.

GOVERNOR is of hydraulic relay type, designed to give very close speed regulation. It is driven from the camshaft through helical gears. Speed regulation is suitable for alternating current generator operation in parallel, and remote speed adjustment is provided for synchronizing purposes. Where the particular service requires it, a variable speed governor is provided.

LUBRICATION is by pressure feed to all bearing surfaces in the totally enclosed engines. Rotary gear pump is driven from the end of the crankshaft through a step-up gear. Suction is from the oil sump in the base, and delivery through edge type filters, and an oil cooler, to the distribution header in the base. Branches from this header lead to all the main bearings, to camshaft gears and bearings, and to valve operating mechanism. Lubricating oil pump is built with excess capacity to permit the use of continuous by-pass lubricating oil filters if desired. Choice of filter type depends somewhat upon circumstances, and is partly optional with the purchaser.



WORTHINGTON MICRO METERING GAS-VALVE
One for each cylinder.

COOLING WATER is usually circulated through the engine jackets by an outside motor driven pump. Main inlet water manifold is secured to the side of the engine frame, with branches leading directly to individual cylinder water jackets. From these jackets, water enters cylinder heads through external water ferrules which are carefully spaced to insure even distribution of flow.

From the heads, water may flow directly to the outlet header or to the exhaust header jacket which also acts as an outlet header. In the former case, the exhaust manifold is cooled by a separate circuit from the inlet manifold to the outlet header, through the exhaust manifold jacket.

In all except a few unusual cases where abnormally soft water is available, a closed cooling system is recommended. It may include any of three arrangements: 1—Shell and tube heat exchanger using cooling water from wells, city water mains, natural bodies of water — including salt water — or from open atmospheric cooling towers; 2—Evaporative cooler, forced draft cooling tower, closed type atmospheric cooling tower, or other types of cooling apparatus having integral closed cooling coils; 3—Fan cooled dry type radiator.

Attached gear driven centrifugal pumps for raw and soft water circulation can be supplied as additional equipment if desired. Thermostatically controlled by-pass valves are available for maintaining a constant cooling water temperature over all load or weather conditions.

AIR INLET MANIFOLD is provided to simplify the mounting of an air filter inside or outside the building as required.

EXHAUST MANIFOLDS are either water cooled or non-cooled insulated type depending on engine rating and service conditions. Air inlet and exhaust manifolds are so arranged that individual or several cylinder heads can be removed and replaced without disturbing the manifold.

DUAL FUEL DIESELS operate on either gas or oil or any combination of the two fuels. Engines can be arranged to operate in several ways. Engine can be instantly converted from gas to oil operation. It may be furnished with either automatic or manual controls to change from gas to oil. Oil operation is restored manually.

MICRO-METERING GAS VALVE—It has been proved in early experiments that one gas valve could not give satisfactory engine operation for either turbocharged dual fuel or spark ignition gas engines. It was found that one valve for each cylinder was required. Well balanced valve design, with cut-off tapers, provides the micro-metering which assures perfect fuel proportioning to each cylinder. This valve, located immediately adjacent to each cylinder, has important advantages over other types which are: (1) Governing at any predetermined speed setting and under every variation of load change is excellent—far better than is possible with any other type of gas valve. (2) The engine load can be uniformly distributed among all cylinders. This prevents overloading of any one cylinder, which cannot be prevented with other types of fuel control. (3) Wear is equalized and maintenance reduced. (4) Because of its design, it provides excellent regulation, particularly at light loads. All Worthington turbocharged engines include the micro-metering valve as standard equipment.

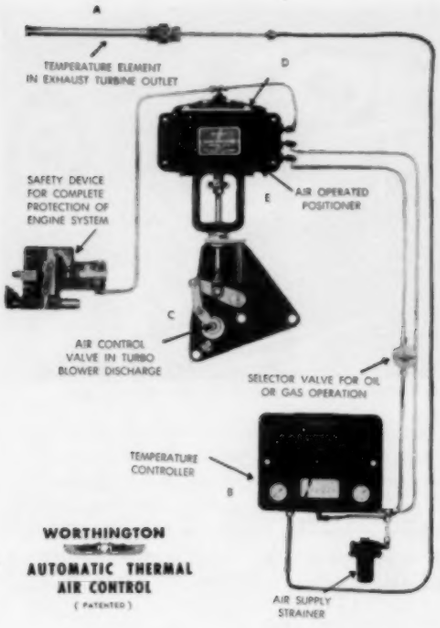
AUTOMATIC THERMAL AIR CONTROL—THE THERMAL THROTTLING PRINCIPLE—Naturally aspirated and turbocharged dual fuel engines operate with improved fuel economy at all loads with a controlled weight of air delivered to the engine cylinders.

AIR FUEL RATIO—Research has shown that with natural gas as a fuel, air supplied in the proportions of 17 to 1 will provide an ideal air-fuel ratio. To maintain this ratio at partial loads, a reduction in the quantity of air delivered to the cylinders is necessary.

HIGHER CYLINDER TEMPERATURE — Unlike the oil Diesel, the gas Diesel will operate more efficiently at partial loads with higher mean cylinder temperatures. The reduction in the excess air cooling resulting from automatic thermal air control, provides higher cylinder temperature and more complete fuel combustion.

THERMAL THROTTLING CONTROL — For most efficient engine performance, exhaust temteratures at reduced loads should be maintained as near to full load valves as possible. The Worthington Automatic Thermal Air Control provides the best means for doing this. Briefly, this control functions as follows:

HOW IT WORKS—A thermometer bulb inserted in the exhaust turbine outlet is connected to an automatic temperature controller by means of capillary tubing filled with an inert gas. Changes in the exhaust temperature (due to load variations) cause a pilot air valve to operate the servo-mechanism. A diaphragm motor and positioner move the damper through a linkage, in response to a changing air pressure supply from the controller—in this case, closing the valve as the temperature is lowered. Engine starting air—at reduced pressure—is used as the power medium.



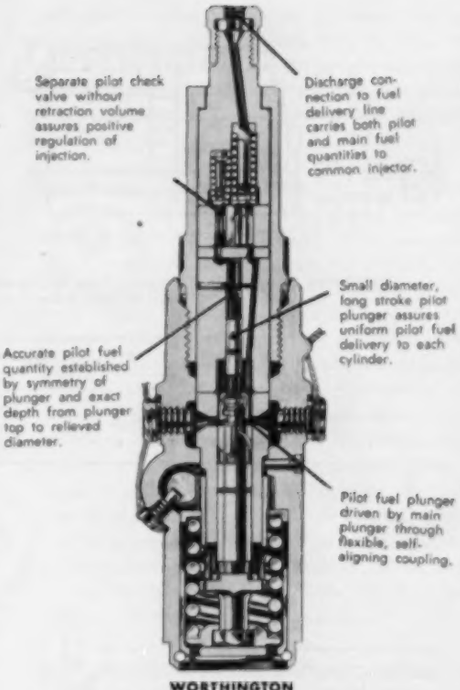
CONTROL SETTING—The thermometer bulb shown at (A) in the diagram, located in the exhaust turbine outlet, will indicate a temperature of approximately 590° to 690° F. (depending on cylinder size and bmep rating) at nominal full load—with a fully opened throttle. At full load, the controller (B) is set to fully open the throttle when the exhaust temperature (indicated on the controller) corresponds to the setting.

When the engine is started, the damper (C) is in the closed position. It will remain there until the load causes the exhaust temperature to reach a predetermined point—when, acting through the controller (B), diaphragm motor (D) and damper positioner (E), it will reposition the damper to maintain the proper air-fuel ratio. This selection and automatic damper positioning varies continually with load changes and maintains the optimum air-fuel ratio at all times.

The features of the Worthington Automatic Thermal Air Control are: (1) The correct air-fuel ratio is supplied to the engine cylinder at all times and in direct relation to all load changes; (2) the most responsive medium (engine exhaust temperature) is utilized to actuate this control; (3) daily and seasonal ambient air temperatures are automatically compensated for with this control which makes it possible for the engine to operate at all times at the highest efficiency

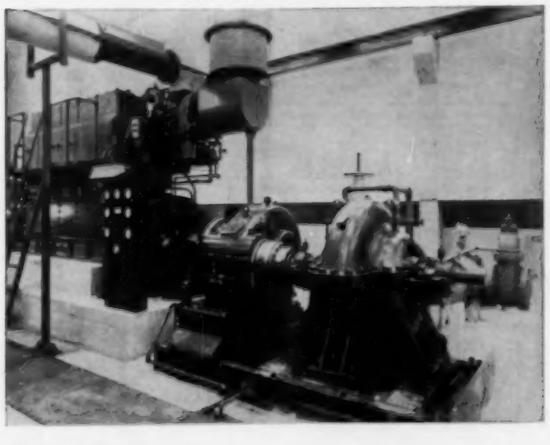
DUAL PLUNGER FUEL PUMP—Individual injection pumps serving power cylinders of Worthington dual fuel diesels perform two functions: (1) accurately meters and injects the small quantity of pilot oil required for the most efficient operation of the engine when using gas fuel; (2) instantaneously handles the total quantity of oil required when the engine is running entirely on liquid fuel. Essentially, therefore, the dual plunger pump is two pumps built in one casing. The cross-section sketch clearly shows the construction features. The proved advantages of an individual injection pump for each power cylinder are as important on a dual fuel engine as they are on an oil-diesel. Perfect timing and controlled cylinder load balance are not obtainable by any other type of injection system. The advantages of this Worthington development pilot plunger addition to a standard fuel injection pump are: (1) Pilot oil—the amount required to ignite the gas fuel, when injected over a relatively long period, with a small diameter plunger, produces perfect atomization and retard detonation. (2) The firing pressures in the cylinders are reduced resulting in more quiet operation and less shock strains in the cylinder structure. (3) Exhaust temperatures are lower, which means longer piston, piston ring, and valve life. (4) Combustion is improved, and fuel consumption[1] is reduced.

AUTOMATIC FUEL SWITCHER—When generating electrical power with Worthington dual fuel diesels equipped with the Worthington patented "Automatic Fuel Switcher," power consumers will never know about fuel gas interruptions or failures. Shutdowns occurring when depending upon manual changeovers during emergencies are now eliminated. When gas pressure drops below normal or fails completely, the engine automatically changes over to 100% fuel oil instantly. Whether operating on gas with pilot oil or 100 percent oil, the Worthington "Automatic Fuel Switcher" places the engine under command of the governor with full travel at its best governing efficiency. Using full travel from no load to overloads steadies governor control of the fuel metering equipment during all load changes This means the best regulation obtainable.


Separate pilot check valve without retraction volume assures positive regulation of injection.
Discharge connection to fuel delivery line carries both pilot and main fuel quantities to common injector.
Small diameter, long stroke pilot plunger assures uniform pilot fuel delivery to each cylinder.
Accurate pilot fuel quantity established by symmetry of plunger and exact depth from plunger top to relieved diameter.
Pilot fuel plunger driven by main plunger through flexible, self-aligning coupling.
WORTHINGTON
DUAL PLUNGER FUEL INJECTION PUMP
PATENTED & PATENTS PENDING

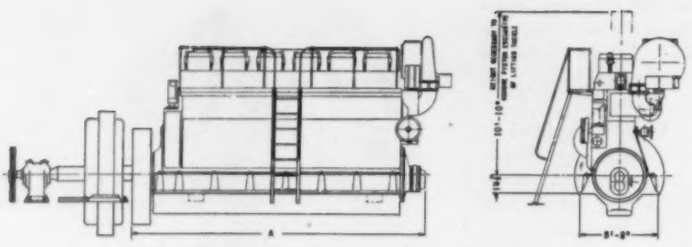
Until Worthington engineers developed the "Automatic Fuel Switcher," only one-half governor travel was available for either gas or oil to provide the automatic change-over—resulting in erratic regulation on generator service.

The "Automatic Fuel Switcher" acts immediately, when the gas pressure in the main supply line to the engine drops below a predetermined minimum—usually 25 psi. It closes the gas metering valves instantly and simultaneously shifts linkages that place the fuel pumps under control of the governor at the required setting for the load at that very moment. Consequently, there is no hunting of the governor when the engine goes over to 100 percent fuel oil. Engine mounted, spring loaded, pneumatic cylinder arranged to engage gas and oil control linkage when gas fails. Pressure controller mounted external to the engine. Controller maintains maximum air pressure on system and keeps it in balance until gas falls below a predetermined minimum value—usually 25 psi. Gas pressure pick-



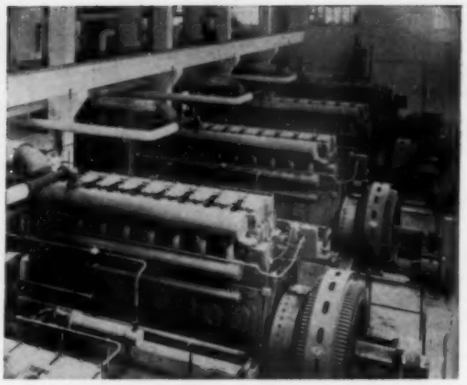
Worthington SEHGO-8 dual fuel diesel installation at the Hyperion Sewage Disposal Plant in Los Angeles, Calif.

Worthington Type SDR-5 turbocharged diesel engine driving centrifugal waterworks pump through speed increaser.

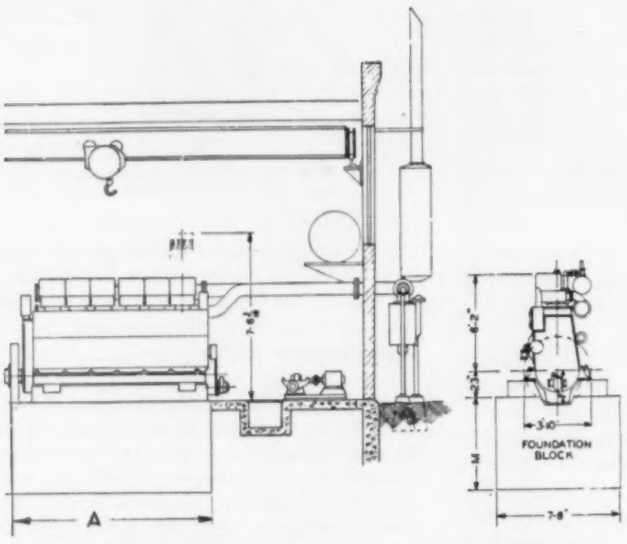


Installation sketch of Worthington Type SEH6 with general dimensions given in table below.

Engine	A	Wgt. of Engine
SEH5	17'- 9"	113,400
SEH6	20'- 1"	126,200
SEH7	22'10"	146,400
SEH8	24'- 8"	157,100

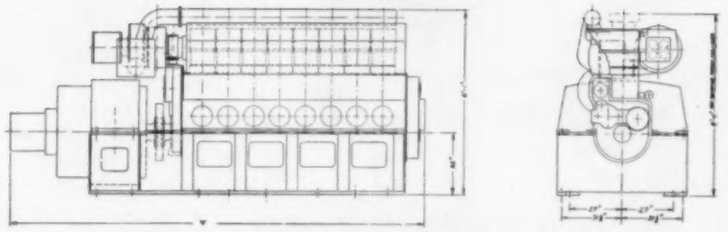


Five Worthington Type SDR-8 turbo-charged diesel-electric units generating power for a radio station.



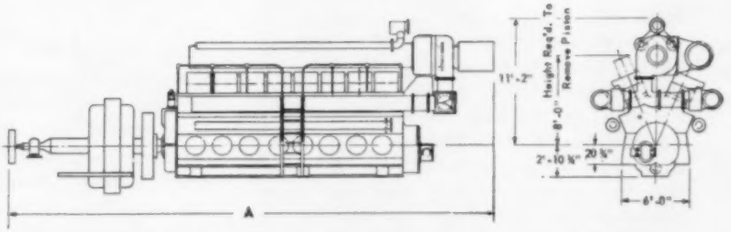
Installation sketch of Worthington Type DH-6, with table of dimensions below.

Engine	A	Wgt. of Engine
SDH6	14'-9"	40,200
SDH8	17'-4"	49,600



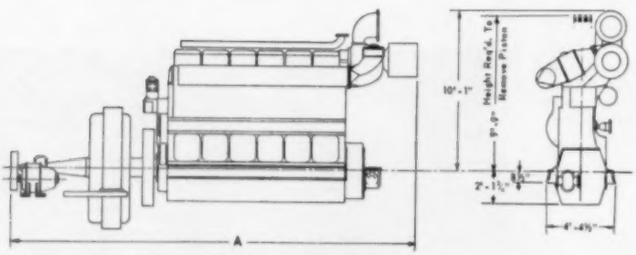
Dimensional sketch Worthington SW9-8. Dimensions of engines appear in table below.

Engine	A	Wgt. of Engine
SW9-6	15'-9"	23,000
SW9-8	18'1"	26,500



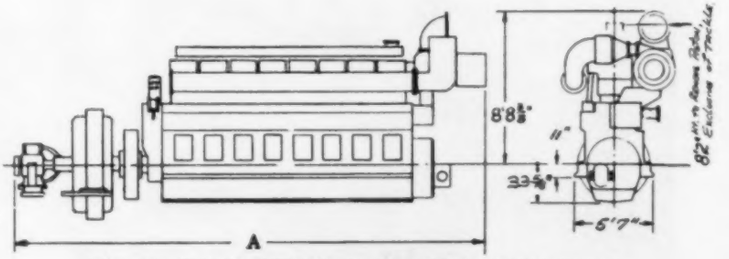
Dimensional Sketch of Worthington Type SW14-16 with general dimensions given in table below

Engine	A	Wgt. of Engine
SW14-12	38'-1"	134,300
SW14-16	42'-9"	169,700



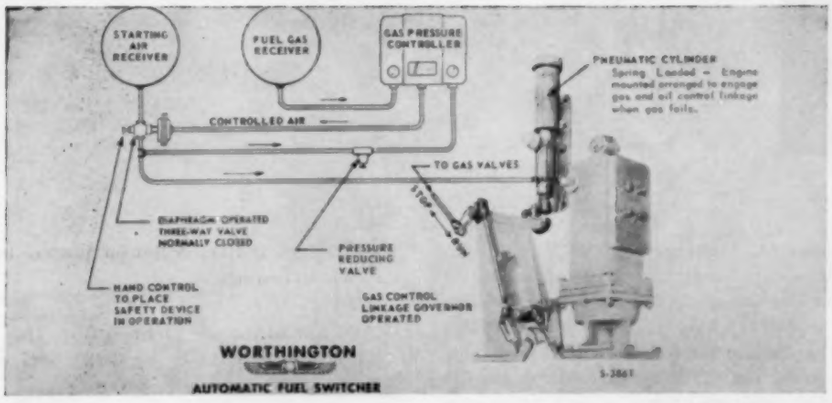
Dimensional Sketch of Worthington Type SDR-6 with general dimensions given in table below

Engine	A	Wgt. of Engine
SDR-5	24'-4"	65,900
SDR-6	26'-4"	72,300
SDR-7	28'-6"	80,000
SDR-8	30'-6"	85,400



Dimensional sketch of Worthington type SW-14-8 In-Line Engine. Dimensions appear in table below.

Engine	A	Wgt. of Engine
SW14-6	27'-10"	82,600
SW14-8	33'- 2"	105,300


STARTING AIR RECEIVER
FUEL GAS RECEIVER
GAS PRESSURE CONTROLLER
PNEUMATIC CYLINDER
Spring Loaded — Engine mounted arranged to engage gas and oil control linkage when gas fails.
CONTROLLED AIR
TO GAS VALVES
STOP
DIAPHRAGM OPERATED THREE-WAY VALVE NORMALLY CLOSED
PRESSURE REDUCING VALVE
HAND CONTROL TO PLACE SAFETY DEVICE IN OPERATION
GAS CONTROL LINKAGE GOVERNOR OPERATED
WORTHINGTON
AUTOMATIC FUEL SWITCHER

up that communicates gas supply pressure to the controller. Three-way valve, single diaphragm operated. It is connected in the air supply line to the pressure controller, and to the pneumatic cylinder. Reduction valves to step starting air pressure down from as high as 250 psi. or as low as 100 psi. to 17 psi. for operation of the pressure controller.

The sequence of operation of the Worthington "Automatic Fuel Switcher" is fairly simple. First, the engine is started and brought up to speed on oil fuel. Then, before manually changing over to gas, the automatic system is engaged so that it will be ready to act in the event of gas failure. The system is engaged and placed in balance by opening the high pressure air valve (actuated by small knob on three-way valve). Air is then admitted to the pressure controller through the air reduction valves and to the pneumatic cylinder mounted on the engine. Through action of the controller, the high pressure air supply valve is held open as long as the gas pressure is at or above an indicated minimum pressure desired for the engine. Until the gas pressure falls below the minimum or fails completely, low pressure air from the controller, acting on the diaphragm always holds the high pressure air supply valve open.

In its raised position, the vertical plunger in the pneumatic cylinder, responding to air pressure unbalances a compression spring. In this position, the plunger remains disengaged from the levers that are connected to the gas and oil control linkage. When gas pressure falls below the minimum required for the engine, the pressure controller releases air to the diaphragm valve which then shuts off the supply air and releases pressure on both the pneumatic plunger and pressure controller. Up until the time that a failure occurs, gas metering valves remain under the control of the governor. However, at the instant of gas failure, air pressure in the pneumatic cylinder is released and the plunger, under spring pressure, engages the change-over linkage.

Immediately, this action closes gas metering valves, opens fuel pumps, and transfers governor control exclusively to the fuel oil system. When gas supply is restored to normal, the sequence of changing the engine back to gas and again placing it under control of the governor and the "Automatic Fuel Switcher" may be repeated.

TURBOCHARGING is applied to all models to provide increased horsepower over that available in naturally aspirated engines. Dual-fuel engines are also turbocharged with similar results. Turbochargers are mounted at the end of the engine with special water-cooled welded type exhaust headers discharging directly into the exhaust turbines of the turbochargers. The blower ends of the turbochargers are connected to the air intake headers. Appropriate changes are made in other details of the engines to provide for the proper scavenging and charging of the cylinders as well as for the increased quantity of fuel required for the increased load capacity.

SHUTDOWNS CONTROLS AND ALARM SYSTEMS can be provided in several combinations. Mechanical speed controls can be arranged to act directly on the fuel pump linkage and shut off the fuel in case the engine exceeds a predetermined speed limit. Devices can be supplied for shutting down the engine in case the jacket water or lubricating oil temperature exceeds a set maximum or in case the jacket water or lubricating oil pressure drops below a set minimum figure. Electrically operated alarms can be combined with these shut down systems or made entirely independent. In addition to sounding an alarm, indicating lights tell what system is in trouble. They can be arranged to warn of misadjustment before the shut down controls take effect if desired, permitting the operator to correct the difficulties before shutting down of the engine occurs.

HEAVY FUEL OIL SYSTEMS are available to handle the heavier distillates as well as crude oils. A variety of pumping and recirculating equipment, together with thermostatically controlled fuel heating units can be supplied. Operating temperature and pressure are adjustable, assuring both pressure and temperature to suit requirements of the heavy fuel used. Because of wide variety of heavy distillates and crudes in use, each case must be studied by itself.

CONTROLS are simplified and concentrated at the operator's station. The instrument panel is adjacent and contains all necessary pressure and temperature instruments and gauges.

EQUIPMENT such as suitable flywheel, platforms and ladders, mufflers, and other items, are supplied according to the needs of the individual installations of the engines.

WORTHINGTON OIL AND DUAL FUEL DIESELS

FOUR CYCLE

NON-TURBOCHARGED				TURBOCHARGED			
Type & No. of Cyls.	Bore & Stroke	RPM	*HP	Type & No. of Cyls.	Bore & Stroke	RPM	*HP
				SW-9-6	9x11	900	955
				SW-9-8	9x11	900	1275
DH-6	12x14	600	610	SDH-6	12x14	600	935
DH-8	12x14	600	815	SDH-8	12x14	600	1250
DR-5	13¼x17½	450	580	SCC-5	10¾x14½	514	515
DR-6	13¼x17½	450	700	SCC-6	10¾x14½	514	615
DR-7	13¼x17½	450	815	SCC-7	10¾x14½	514	720
DR-8	13¼x17½	450	930	SCC-8	10¾x14½	514	825
EH-5	16x20	360	775	SDR-5	13¼x17¼	450	1030
EH-6	16x20	360	935	SDR-6	13¼x17¼	450	1235
EH-7	16x20	360	1090	SDR-7	13¼x17¼	450	1415
EH-8	16x20	360	1245	SDR-8	13¼x17¼	450	1645
				SEH-5	16x20	360	1375
				SEH-6	16x20	360	1650
				SEH-7	16x20	360	1925
				SEH-8	16x20	360	2200
				SW-14-6	14x18	450	1875
				SW-14-8	14x18	450	2500
				SW-14-12	14x18	450	3750
				SW-14-16	14x18	450	5000

*Current ratings. Increased horsepower is available on some models. Refer to Engine Sales Division, Worthington Corporation.

BALDWIN-LIMA-HAMILTON

THE present Baldwin-Lima-Hamilton line of Diesel engines for stationary, portable, marine, and railroad locomotive service embodies the engineering experience of more than half a century of internal combustion engine manufacture. Forerunners of the present Baldwin Diesels have a long history of successful, low-maintenance service in a wide variety-of applications such as pipe lines; breweries; municipal and private light and power plants and water pumping stations; railroad motive power; and main propulsion and auxiliary marine service.

BALDWIN—SERIES 600

The Series 600 engine, having a 12¾-in. bore and 15½-in. stroke, is suitable for all types of services listed above, and is available for applications ranging from 430 to 1750 horsepower at speeds of 360 to 625 r.p.m. Although widely used in stationary service, the most extensive application of this engine has been in railroad service, and is proving its dependability and economy in many hundreds of Baldwin locomotives in this country and abroad.

The series 600 is arranged for both diesel and dual fuel operation, the dual fuel equipment consisting of a pressure regulator for the gas supply, special inlet manifold and pneumatically operated butterfly valve for inlet air control.

The Series 600 engines are four-cycle single acting types, and are built either naturally aspirated or turbocharged. The engines are built with open combustion chambers formed in the top of the piston, and with central fuel injection in the cylinder head. They have oil-cooled pistons, welded steel engine beds and frames, and four-valve cylinder heads. The following specifications give detailed construction features of each major component.

BEDPLATE is a welded steel structure. Heavily ribbed flanges along the sides provide rigidity and provide for securing the engine unit to the foundation. In railway units and also in semi-portable and skid-mounted units, the bedplate is extended at the flywheel end to take the generator. Cross members of the bedplate are bored for the crankshaft main bearings. Top flanges are planed for mounting the frame on top of the bedplate.

FRAME is of welded steel construction, which combined with the bedplate gives a rigid engine structure of uniform material. The upper part of the frame acts as a water jacket for the cylinder liners. A trough along the front of the frame provides for mounting the camshaft with its accompanying parts. Cylinder heads are bolted to the top plate of the frame. Easily removable round handhole plates give access to the crankcase space and bearings from both sides of the engine.

CYLINDER LINERS are of removable type, made of high tensile cast iron, porous chrome plated, and are fitted into the upper section of the frame.

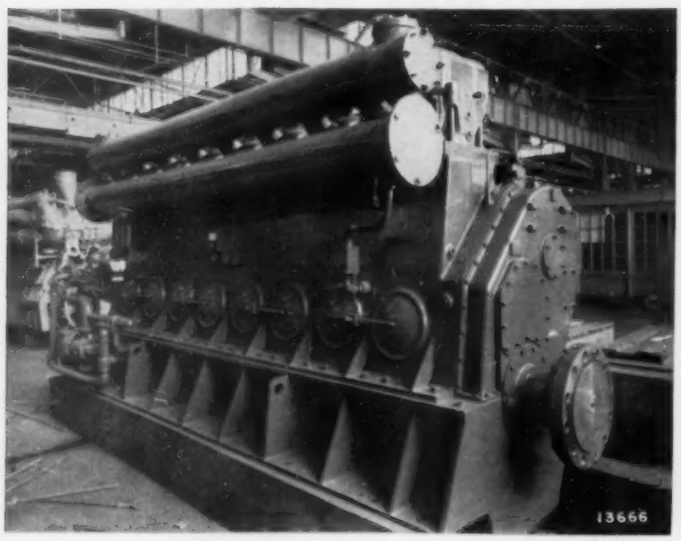
CRANKSHAFTS are made from heat-treated, solid steel forgings, and are drilled for pressure lubrication to all bearings.

MAIN BEARINGS are precision type. They are held in the bedplate by rigid cast steel caps.

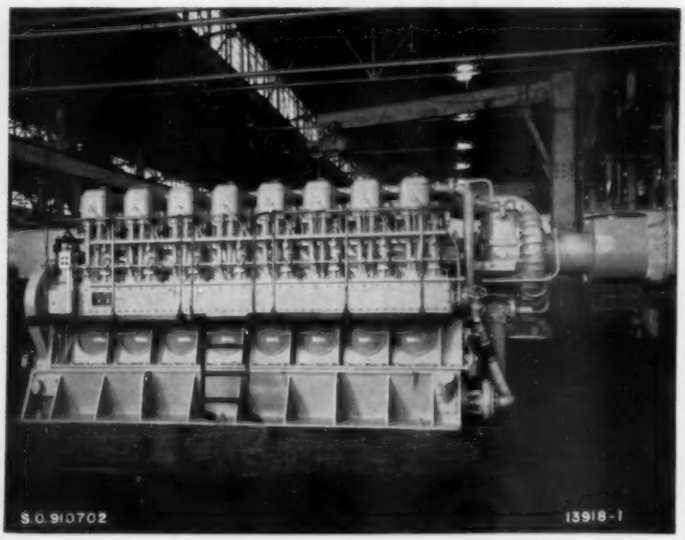
CONNECTING RODS are drop forged steel with "I" section bodies, and rifle drilled for conveying lubricating oil to piston pin bearings and for cooling the pistons. Crankpin bearings are same construction as main bearings, and held by forged steel cap with four bolts. Upper ends of rods have bronze piston pin bushings.

PISTONS are of aluminum alloy. They are oil cooled by a constant flow of lubricating oil passing through the piston crown. The full floating hardened-and-ground piston pin is carried in the cross bore, with the ends of the bore plugged to retain the lubricating oil inside the piston.

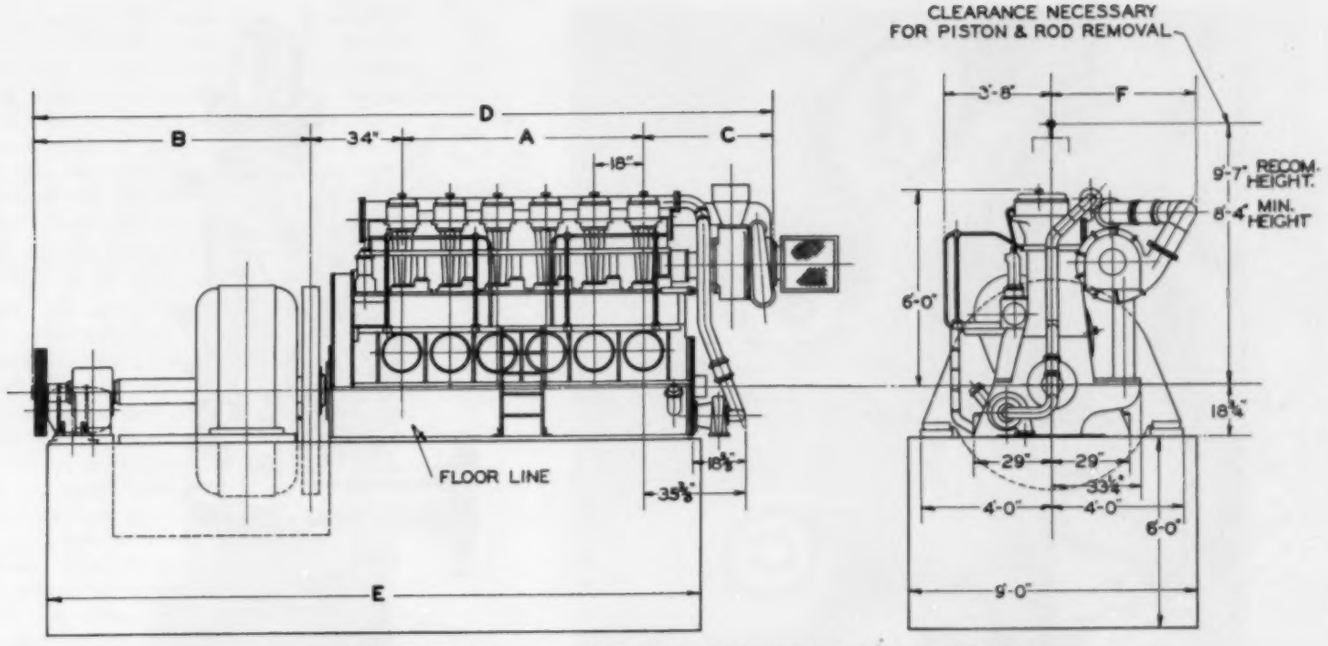
CYLINDER HEADS are individual, of high tensile cast iron, Each head has two air intake and two exhaust valves, all of alloy steel, with the fuel injector located in the center of the head. Marine and stationary engines have air starting valves also. Brackets bolted to the top of the heads carry the rocker arms for actuating the inlet and exhaust valves. These rockers in turn are actuated by pushrods from the camshaft. A two-piece aluminum cover on top of each head encloses the valve mechanism. Pushrods are enclosed in tubes extending from underneath the head flange down to the top of the camshaft housing.



Model 608-NA, eight-cylinder, four-cycle for stationary service.



Model 608-SC, eight-cylinder, four-cycle for stationary service.



OVERALL DIMENSIONS OF SERIES 600 ENGINES FOR STATIONARY SERVICE

Normally Aspirated Engines								Supercharged Engines							
No. Cyl.	A	B	C	D	E	F	Found. cu. yds.	No. Cyl.	A	B	C*	D*	E	F	Found. cu. yds.
6	7'-6"	7'-3"	35⅜"	20'- 6⅜"	18'-11"	32"	37	6	7"-6"	7'-7"	3'-10"	21'-9"	19'- 4"	4'-6"	38
8	10'-6"	7'-7"	35⅜"	23'-10⅜"	22'- 3"	32"	43	8	10'6"	9'-0"	4'- 4"	26'-8"	23'-10"	4'-9"	47

ENGINE DATA — SERIES 600 ENGINES FOR STATIONARY SERVICE

Cycle	B. H. P. Range (Refer to Rating Curves)		Cyls.	Bore Inches	Stroke Inches	R. P. M. Range	Starting System	Application	
	Normally Aspirated	Super-Charged						Stationary	Marine
4	430- 825	650-1310	6	12¾	15½	360-625	AIR	YES	YES
4	575-1000	865-1750	8	12¾	15½	360-625	AIR	YES	YES

* NOTE—If turbocharger can be located on the flywheel end of engine, dimensions "C" and "D" will be reduced by 10⅝" for 6 cylinder units and 1'—4⅝" for 8 cyl. units. All dimensions are preliminary only and are not to be used for construction. Actual generator and exciter dimensions will vary with make and type selected. Foundation size is for engine with A.C. generator and V-belted exciter.

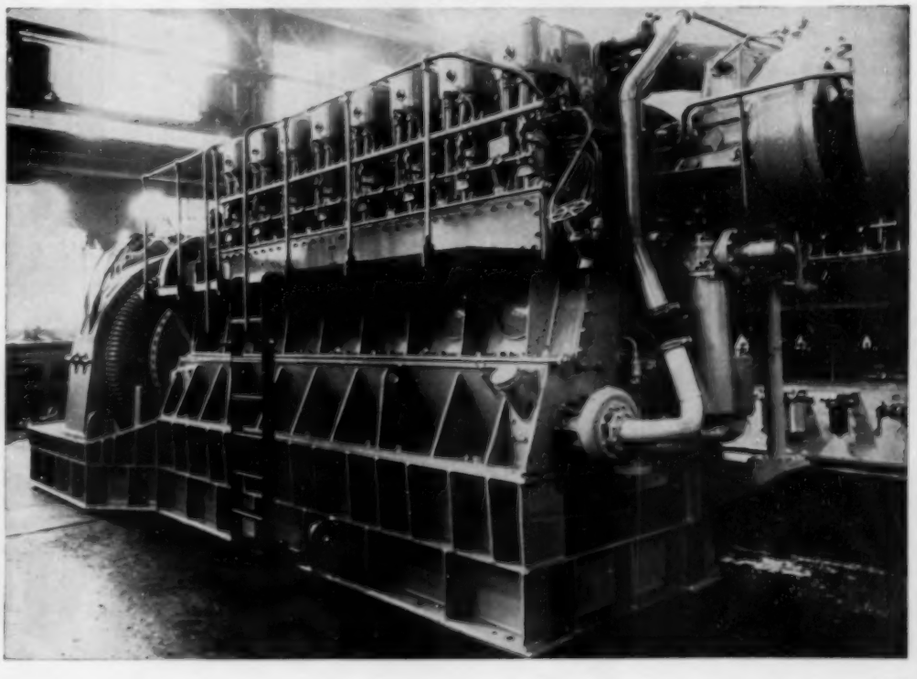
CAMSHAFT is driven from the crankshaft by a roller chain drive at the flywheel end of the engine. An adjustable idler is provided for maintaining proper chain tension. Camshaft is mounted in split-type removable bearing shells.

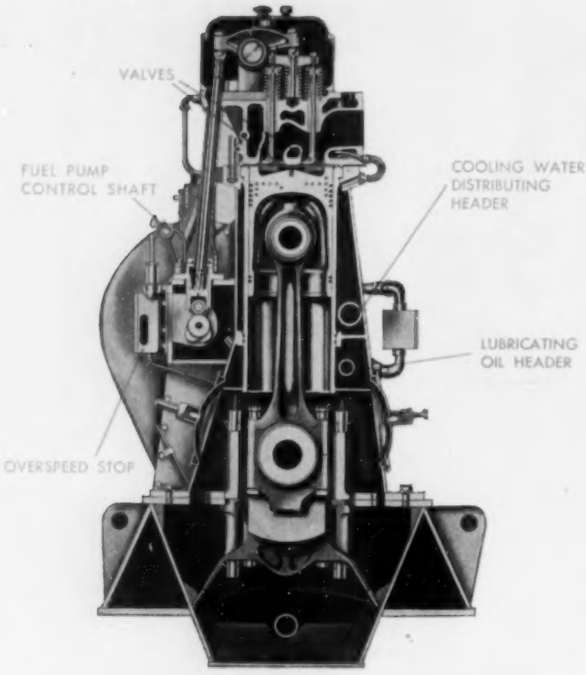
FUEL INJECTION pumps are individual and located opposite each cylinder. They are mounted on top of the camshaft housing and driven directly from the fuel cams on the camshaft. Fuel injectors are of the spring loaded, multi-hole type. Pumps are controlled by the hydraulic relay type governor, gear driven from the camshaft, and mounted on the housing at the drive end.

TURBOCHARGERS, when used, are mounted on the back of the engine. Both intake headers and exhaust headers run along the back of the cylinder heads.

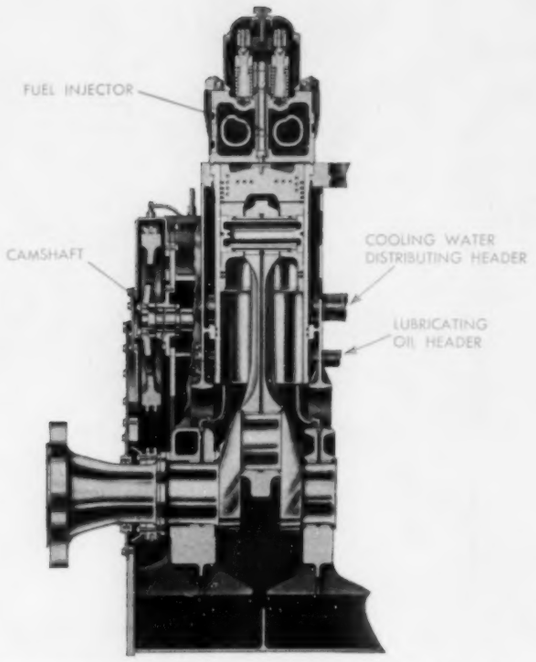
LUBRICATION of all parts needing it is by pressure feed. A positive displacement type pump takes its suction from the sump in bedplate and delivers through a cooler and strainer to the engine distribution header. All bearings, including rocker arm bushings, are under full pressure.

Model 608 SC, 8-cylinder, 4 cycle for generating service.





CROSS SECTION OF SERIES 600 ENGINE



LONGITUDINAL SECTION OF SERIES 600 ENGINE
CYLINDER NO. 1

COOLING WATER is circulated through the cylinder and head jackets by a centrifugal pump. The details are arranged to suit the individual installation conditions.

STARTING of stationary and marine engines is by compressed air. The starting valves in the cylinder heads are timed by a distributor on the end of the camshaft. Locomotive engines are started by motorizing the generator.

EQUIPMENT AND ACCESSORIES are added to the engines as is necessary to suit the installation.

HAMILTON 2-CYCLE SINGLE-ACTING DIESEL AND DUAL FUEL ENGINES

Engine Features

The Series 21-SA engine is built for marine and stationary service. Cylinders are 21½ by 27½ inches. Made in from five to twelve cylinders per unit, ranging in speed from 257 to 277 rpm., the power range is from 2600 to 6720 net brake horsepower, including dual fuel service when built as dual-fuel engines. Marine engines are direct reversible. Scavenging air is furnished by either an attached Roots type blowers or by an independent blower of the rotary positive or centrifugal type.

The Hamilton Dual-Fuel engine design is of the low gas pressure type, using hydraulically actuated gas admission valves with fineness of control equal to that of fuel injection. This advanced design affords absolute safety of operation.

The combination of the carefully designed cylinder head, pilot oil and gas control and of the most modern scavenging system produces unequaled dual fuel engine operation.

The cross section view shows the details of the construction. The cast iron cylinder blocks rest on a welded steel upper base and are held securely to the cast iron bedplate by tie rods which extend

HAMILTON 21½" X 27½" DIESEL
SINGLE ACTING TWO CYCLE ENG. WITH ROTARY VALVE

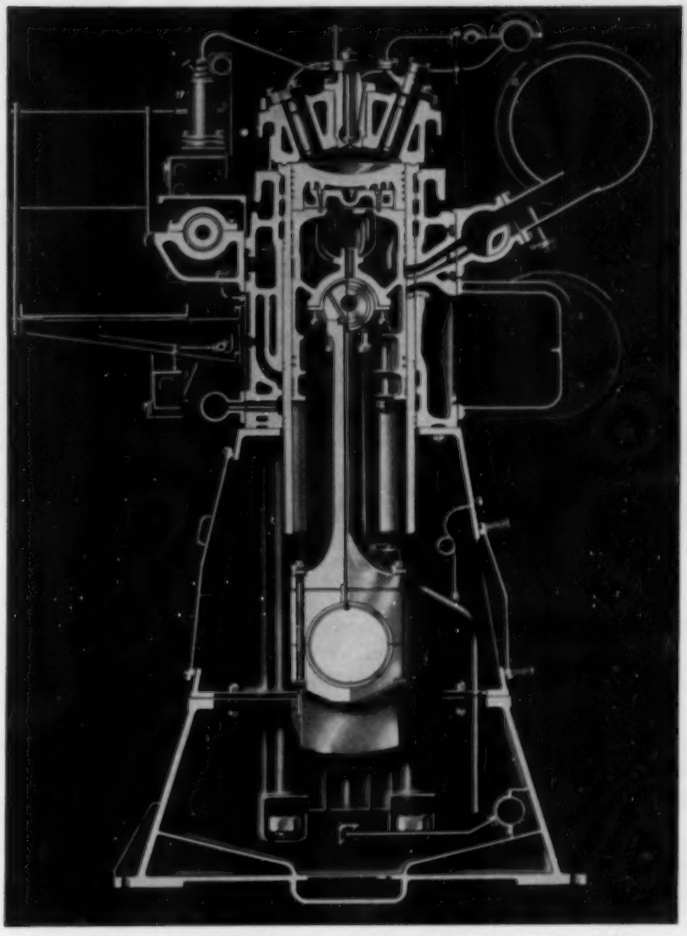
from the top of the blocks to the bottom of the bedplate. These tie rods are located in the four corners of each cylinder and are pre-loaded so that the engine structures will be relieved of any tension load. Cylinder blocks are cast in pairs. Cylinder liners are of special grade cast iron and are set into the cylinder blocks from the top. Space between liner and block forms a passage for the cooling water. The ribs of the cylinder jacket are located so as to direct the flow of water to give most effective cooling.

Loop type scavenging system is used. Inlet ports in the block and cylinder liner are located below the exhaust ports, and both sets are mounted on the same side of the cylinder with the scavenging air header and the exhaust header running along side of the block. The angle and shape of the inlet ports and piston crown direct scavenging air up the opposite side of the cylinder where it is deflected at the top of the cylinder, carrying the exhaust gases down and out the exhaust ports, directly above the incoming scavenging air. Exhaust ports direct the gases out of the cylinder with a minimum resistance to flow. This insures complete clearing of exhaust gases from the cylinder with a minimum amount of scavenging air. The rotary valve shown in the exhaust passage next to the cylinder block entraps 40% extra air in the cylinder after the scavenging process is completed with resultant increase in power output with no increase in cylinder pressures or temperatures. The schematic drawing of the rotary valve action illustrates how the tremendous increase in cylinder air is accomplished.

The crankshaft is forged from high grade open hearth steel, and is drilled for pressure lubrication flow from main bearings to crankpin bearings. Main bearing shells are made in halves and lined with Satco metal. Lower halves are fitted in recesses in the bedplate cross girders. Upper halves are held by caps fitted to the bedplate and secured by adjustable jack bolts. The main bearing shells fit into precision seats milled through the bed and upper saddle for perfect alignment.

The high grade steel connecting rod is the marine type with a three-piece construction to facilitate removal. The crankpin bearing shells are in halves and lined with Satco bearing metal. Crank boxes are bolted to rod foot by four reamed bolts. Connecting rod is drilled up the center and through the wrist pin to carry oil to the wrist pin bearing and to the piston head for cooling. The steel wrist pin is doweled and bolted to the top end of the rod. Wrist pin bearings are steel shells lined with babbitt metal and are held securely in the piston with studs. These bearing shells are constructed to give the maximum bearing surface on the upper half of the shell which carries the load.

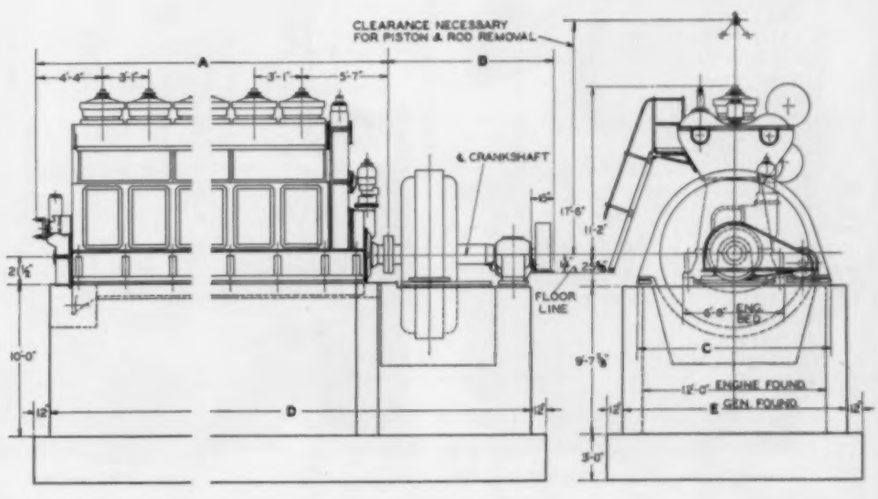
Two-piece pistons are used; the oil-cooled cast iron head carries five compression rings, and the cast iron skirt carries the two oil scraper rings. Three Allen metal wear rings are located at the top and at the bottom of the skirt. An oil cooling spiral on the under side of the piston head directs the flow to ensure proper cooling. Cooling oil return is down through a drill line in the piston skirt issuing into a stationary oil collector for each piston.

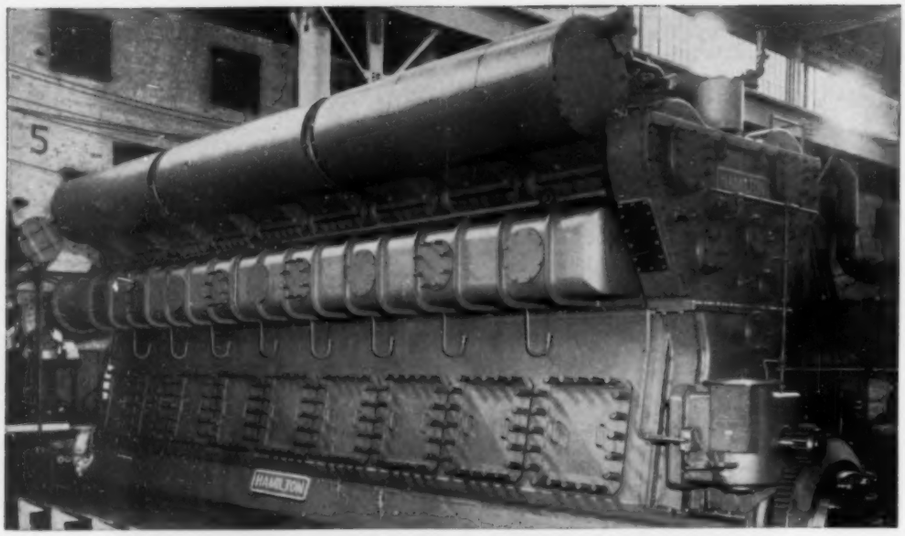


Cross section of Series 21-SA Hamilton Diesel arranged for dual-fuel operation.

Principal Dimensions of Model 21SA Hamilton Diesel Generating Unit.

No. of Cyls.	A	B	C	D	E	Found. cu. yds.
5	22'-3"	9'-8"	12'-8"	32'-4"	15'-0"	205
6	25'-4"	10'-6"	12'-8"	35'-9"	15'-0"	228
7	28'-5"	11'-4"	12'-8"	39'-2"	15'-0"	251
8	31'-6"	11'-4"	13'-3"	42'-7"	15'-3"	274
9	34'-7"	11'-4"	13'-3"	46'-0"	15'-3"	297
10	37'-8"	12'-5"	13'-3"	53'-2"	15'-3"	320
12	45'-4"	13'-6"	14'-5"	59'-4"	16'-6"	370





Hamilton Model 921-SA, 9-cylinder Diesel installed with generator.

Individual cast iron cylinder heads are bolted to the top of the cylinder block, and have the fuel spray valve in the center, the air starting valve and the gas inlet valve for dual-fuel engines. Air starting valves are actuated by pilot air from a distributor on the camshaft. Gas inlet valves are of poppet type and are hydraulically actuated by modified fuel injection pumps with helix port control. Gas injection is at the beginning of the compression stroke just after closure of the exhaust ports.

Individual fuel injection pumps are mounted opposite each cylinder above the camshaft which actuates them. Camshaft trough and casings are secured high on the side of the cylinder block just below the cylinder heads. Camshaft is driven by a gear train at the flywheel end of the engine.

Lubricating oil pumps are mounted at the free end of the engine. Circulating water is supplied by independent pumps. Lube oil cooler, lube oil strainer, fuel filter and all the necessary pressure gauges and thermometers are standard equipment on these engines. See Baldwin-Lima-Hamilton data tabulation schedule.

A turning gear is provided complete with motor and control at the coupling end of the engine.

All main driving parts are subject to forced lubrication, including the drive of the fuel pump. The cylinders are lubricated by mechanically operated lubricators. Piston cooling oil bearings, running gear, and gear train bearing lubrication are supplied at 30-40 lb. pressure.

The engine is provided with exhaust piping connecting the various cylinders and forming a common outlet. The piping is made of welded steel or cast iron lagged with asbestos and protected by sheet iron.

BALDWIN-LIMA-HAMILTON CORPORATION DIESEL AND DUAL FUEL ENGINES

MODEL		CYCLE	BORE AND STROKE	NO. OF CYL.	R.P.M.	B.H.P.
BALDWIN	606-NA x	4	12.75 x 15.5	6	360-625	430-825
BALDWIN	608-NA	4	"	8	"	575-1000
BALDWIN	606-SC z	4	"	6	"	650-1310
BALDWIN	608-SC	4	"	8	"	865-1750
BALDWIN	‡ G-606-NA	4	12.75 x 15.5	6	"	430-825
BALDWIN	G-608-NA	4	"	8	"	575-1000
BALDWIN	G-606-SC	4	"	6	"	650-1125
BALDWIN	G-608-SC	4	"	8	"	865-1500
HAMILTON	521-SA	2	21.5 x 27.5	5	257-277	2600-2800
HAMILTON	621-SA	2	"	6	"	3120-3360
HAMILTON	721-SA	2	"	7	"	3640-3920
HAMILTON	821-SA	2	"	8	"	4160-4480
HAMILTON	921-SA	2	"	9	"	4680-5040
HAMILTON	1021-SA	2	"	10	"	5200-5600
HAMILTON	1221-SA	2	"	12	"	6240-6720
HAMILTON	‡ G-521-SA	2	"	5	257-277	2425-2600
HAMILTON	G-621-SA	2	"	6	"	2910-3120
HAMILTON	G-721-SA	2	"	7	"	3395-3640
HAMILTON	G-821-SA	2	"	8	"	3880-4160
HAMILTON	G-921-SA	2	"	9	"	4365-4680
HAMILTON	G-1021-SA	2	"	10	"	4850-5200
HAMILTON	G-1221-SA	2	"	12	"	5820-6240
HAMILTON	† RB-521-SA	2	"	5	260	2450
HAMILTON	RB-621-SA	2	"	6	"	2940
HAMILTON	RB-721-SA	2	"	7	"	3430
HAMILTON	RB-821-SA	2	"	8	"	3920
HAMILTON	RB-921-SA	2	"	9	"	4410

† Prefix R denotes direct reversing engines.

† Prefix R denotes direct reversing engines; B denotes attached scavenging air blower.

‡ Prefix G denotes dual fuel engines.

x NA denotes naturally aspirated.

z SC denotes supercharged engines.

HERCULES

INDUSTRIAL, MARINE, AUTOMOTIVE AND PORTABLE DIESELS

HERCULES diesel engines, offered with two distinctly different combustion systems, are of the light-weight, high-speed, heavy-duty, solid-injection, four-stroke cycle type. Introduced in 1931 the Hercules diesel has been developed to have comparable speed, overall space and mounting dimensions and horsepower output with the Hercules gasoline engines. In fact many of its turbulence chamber type of diesels and all of its new direct-injection type of Diesels have exactly the same mounting dimensions as their counterparts in the Hercules gasoline line.

In its new models of direct-injection diesels, known as the "D.D." series, the degree of interchangeability between these engines and the new "G.O." overhead-valve gasoline engines, has been advanced to a maximum. Not only are these two different types of spark and compression ignition engines interchangeable as units but their design makes maximum use of common components such as cylinder blocks, oil pans, crankshafts, camshafts, gear covers, fly-wheel housings, bearings, connecting rods, valves and valve guides. The degree of interchangeability is further carried out by the extensive use of certain components over the entire range of six diesel and six gasoline models.

Also underway in the company's development program are additional models of these companion diesel and gasoline engines in one, two and three-cylinder construction, matching the bore sizes and incorporating the same interchangeable features of the four and six-cylinder engines. In both the turbulence-chamber and direct-injection types of diesels, weights are reasonably close to those of gasoline engines of comparable size. The diesels range from 4 to 500 horsepower with piston displacements varying from 42 to 1468 cubic inches. At present they are built in one, two, four, six and eight cylinders in 18 series and 44 models.

Although comparable in space, weight and horsepower output, Hercules Diesels are not conversions of gasoline engines but are designed and built strictly as diesels for high-speed, heavy-duty service. The turbulence-chamber type of diesel is designed for maximum speeds which rank among the highest for automotive diesel engines anywhere in the world. The direct-injection diesel is designed for lower or moderate speed operation.

Light-weight and compactness, which are features of the Hercules Diesels, are achieved by the proper choice of metals and in the design and construction of the various components. Hercules Diesels are so constructed and arranged that they can be applied and installed in a wide variety of equipment for many different uses. Modifications to the "basic" engine can be readily made to meet the many diversified service and installation requirements. Any model can be supplied with different sizes of flywheels, flywheel housings, various exhaust and inlet manifold arrangements, different positioning of mounting pads, varying arrangements of oil pans, front end gear covers, different mountings for the cranking motors, various sizes and types of battery-charging generators, air intake heaters, exhaust mufflers and other accessories.

CYLINDER BLOCK AND CRANKCASE are cast integral of special cylinder alloy-iron. Water jackets covering the full length of the cylinder are standard. Liners, where used, are of the dry type and may be pressed out and replaced.

Lower cross members of the crankcase are machined for the main bearings of the crankshaft which is held in place by heavy bearing caps of rigid construction. There is a main bearing on either side of each cylinder. The oil pan bolts to the bottom of the crankcase.

CRANKSHAFT is drop forged steel. Main journal and crankpin surfaces are induction hardened and accurately ground to close tolerances. The shaft is rifle drilled for lube oil circulation.

CONNECTING RODS are alloy steel, drop forged with I-section bodies. Upper ends are fitted with bronze bushings for piston pin bearings. Lower ends have drop forged steel bearing caps.

PISTONS are of special aluminum alloy developed for low expansion, slow growth, excellent wearing qualities and general long-life service. Case-hard-

Longitudinal cross-section of Hercules turbulence-chamber type of Diesel.

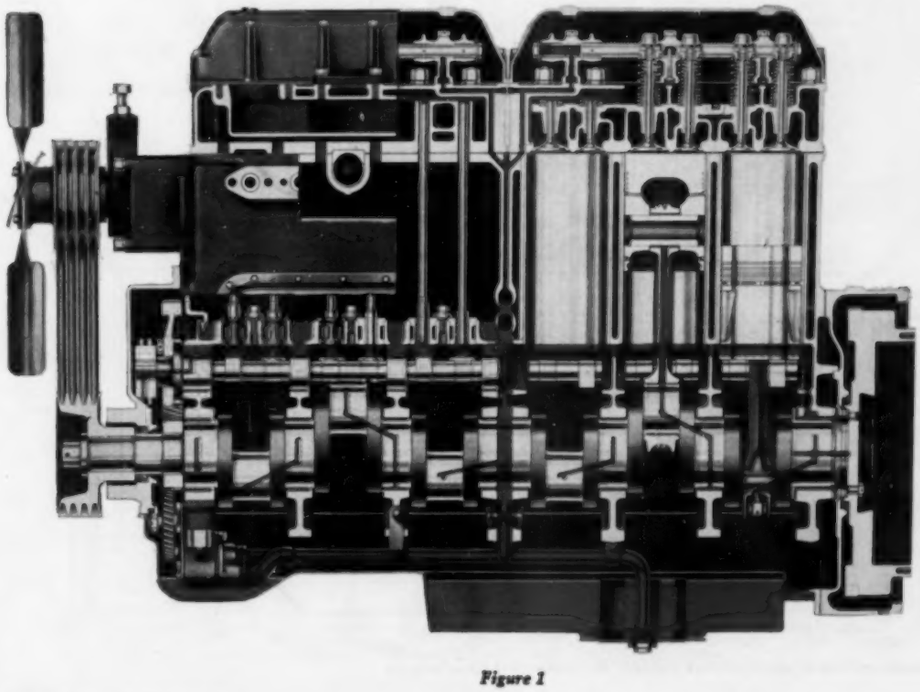


Figure 1

End cross section of Hercules DFX turbulence-chamber Diesel.

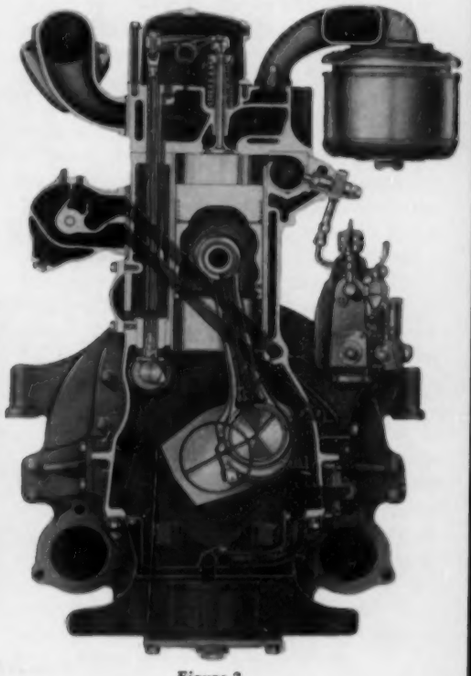


Figure 2

ened piston pins of ground steel are of the full-floating type. Compression piston ring specifications vary with the service and size of engine. Three rings are typical but several models use four, and the top ring in the larger sizes is a keystone ring. All rings are special plated or coated. Oil drain rings are provided above and below the piston pin and the specifications for them vary according to the engine speed and service, to give the user optimum results.

CYLINDER HEADS are of special alloy cast iron and are secured to the top of the cylinder block with heat-treated alloy steel studs. Cylinder head gaskets are of solid metal construction about 1/16 of an inch thick.

VALVES are of special alloy steels chosen especially for their long service life. They are thoroughly cooled by the circulation of the cooling water. Inlet and exhaust valves are operated by rockers and pushrods from the camshaft mounted in the crankcase. Rockerarms are of steel, bronze-bushed at the fulcrum.

ROCKERARM SHAFT, supported by brackets on top of the cylinder head, is hollow with ends plugged. Overflow at one end flows onto valve stem, and at the other end, down the pushrod to the cam tappet guide.

CAMSHAFT has integral cams with surfaces hardened and accurately ground to correct contours. Camshaft bearings are of liberal size. The drive is from the front end of the crankshaft by wide-faced helical gears of steel. Cam tappets are guided securely in the crankcase and the hollow pushrods extend from the tappets to the rockerarms above the cylinder head. The entire valve mechanism is fully enclosed. Covers on top of the cylinder heads are easily removed for inspection purposes.

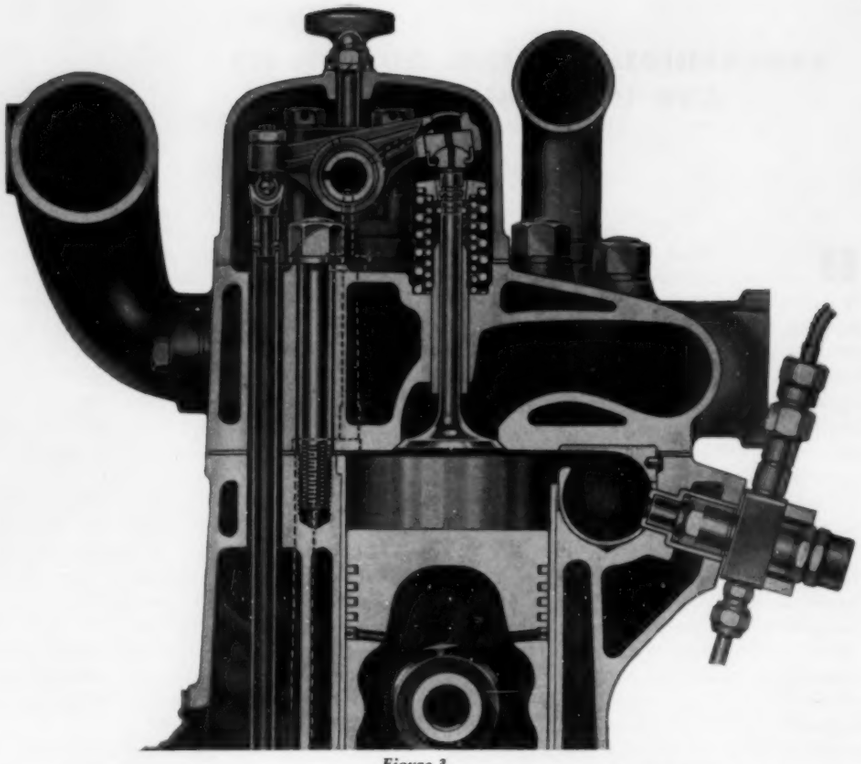


Figure 3
Cross section of Hercules turbulence-chamber Diesel cylinder head showing arrangement of spherical combustion chamber.

FUEL INJECTION—Pumps are either American Bosch, which are available for all engines, or the Roosa Master Pump, which also is available for all except the largest sizes of engines.

GOVERNOR type is selected according to the service required. Vacuum governors are used on some automotive applications. Flyball governors, of different designs, also are used to meet various requirements. Hydraulic governors are available for some engines where extremely close regulation is a requirement, such as in generator applications.

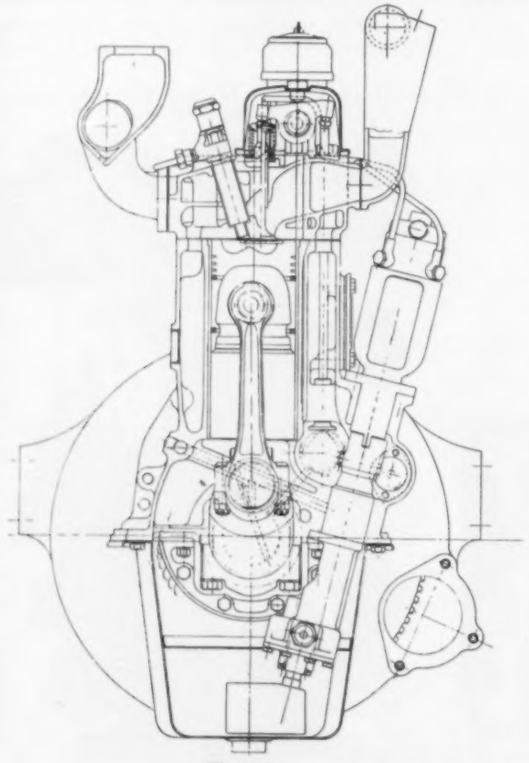


Figure 4

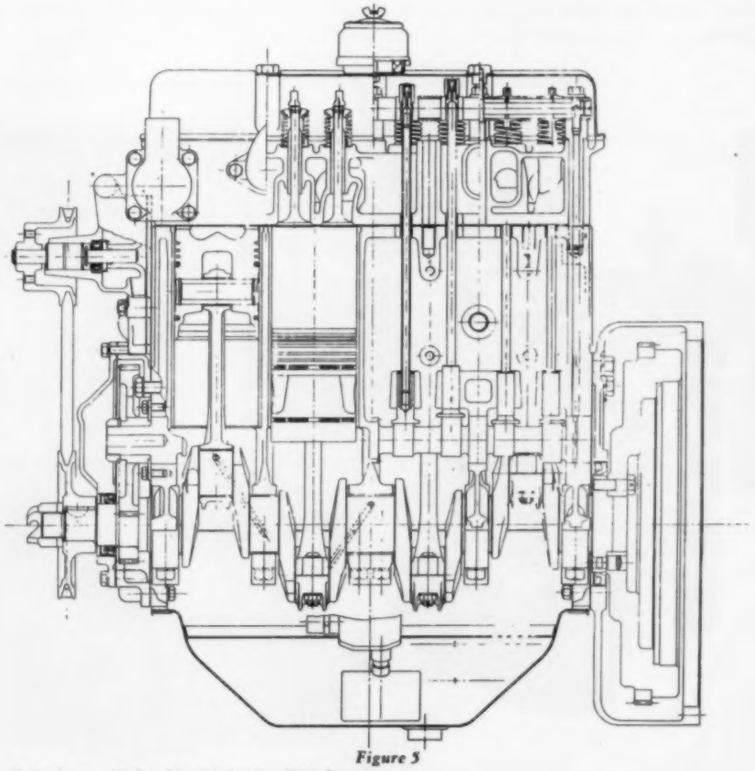


Figure 5

Cross and length sections of the D.D. four cylinder direct-injection Diesel engine.

Figure 6
Cross section showing Mexican Hat Type Combustion Space in Crown of Piston in Hercules Direct-Injection Diesel.

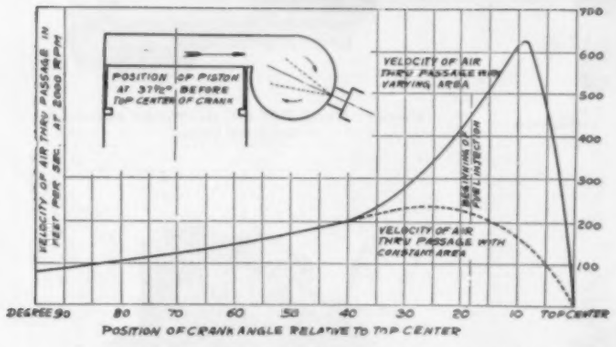
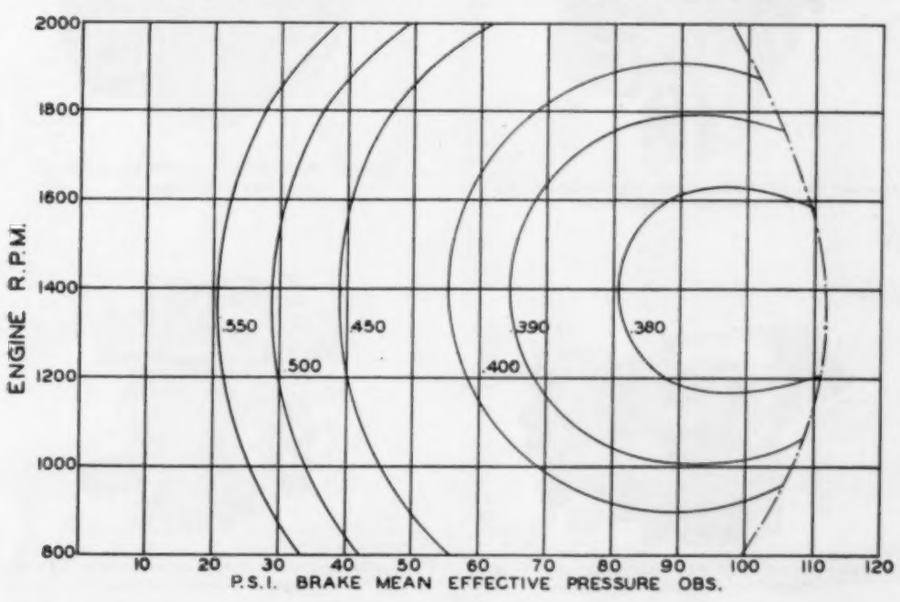

VELOCITY OF AIR THRU PASSAGE IN FEET PER SEC. AT 2000 R.P.M.
POSITION OF PISTON AT 37½° BEFORE TOP CENTER OF CRANK
VELOCITY OF AIR THRU PASSAGE WITH VARYING AREA
BEGINNING OF FUEL INJECTION
VELOCITY OF AIR THRU PASSAGE WITH CONSTANT AREA
700
600
500
400
300
200
100
DEGREE 90 80 70 60 50 40 30 20 10 TOP CENTER
POSITION OF CRANK ANGLE RELATIVE TO TOP CENTER

Figure 7
Chart illustrating air velocity in the combustion chamber with respect to piston position.

Figure 8
This illustrates the air velocity in the turbulence-chamber with respect to piston position.



LUBRICATION is by pressure feed to all vital bearing surfaces. The gear-type pump is located in the crankcase below the crankshaft and is gear driven. Suction is through adequate strainers on the suction side of the pump and a fine filter is provided on the pressure side. The filter is provided with a by-pass valve to pass oil along in the event the filter should become clogged by dirt. A pressure relief valve regulates the oil pressure and sends surplus oil back to the crankcase sump. Oil to the bearings and parts flow through drilled passageways in the cylinder block and crankcase, cylinder heads and front end gear cover. Cylinder walls are lubricated by splash from the crankshaft bearings.

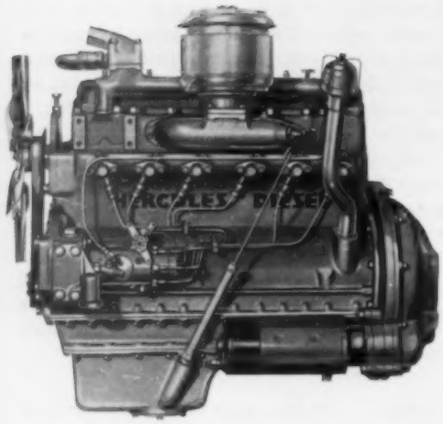
COOLING—Cooling water is circulated in automotive type engines by a centrifugal pump.

STARTING—Cranking of the engines is accomplished with either an electric motor, compressed air, hydraulic motor or a small gasoline engine. (See Figures 9, 10 and 11.) Basis for the selection is the type most suitable for the intended engine service. All types use a ring gear on the flywheel and the typical Bendix or Dyer automatic drive with pinion engaging the flywheel ring gear. A minimum diesel engine speed of from 180 to 250 rpm is necessary for sure ignition of the fuel. Electric cranking motors are 12 or 24 volt, according to the size of the engine. The compressed air motor or hydraulic motor occupies about the same space and approximates the weight of the electric motor. When used, they replace the electric starter on the diesel engine. The gasoline cranking engine has its field of application. In addition to the automatic engaging drive on the flywheel gear, there is a manually-controlled clutch so that the gasoline engine can be hand cranked for starting and disconnected when not in use. Examples of all types are shown.

ACCESSORIES vary with the service conditions, but when radiator cooling is used the fan is V-belt driven from the front of the crankshaft. Electric generators, when used, are gear driven from the crankshaft or are included in the fan drive, or may have their own V-belt drive.

While the foregoing information applies generally to both types of Hercules Diesels there are certain features of each type that invite further comment. The well-known Hercules turbulence-chamber type of combustion chamber is in the form of a sphere located on the side of cylinder block and has a passage connecting it with the cylinder. The lining of this combustion chamber is made of heat resisting steel and seldom requires replacement. Positioning of the chamber can be seen in Figures 2 and 3.

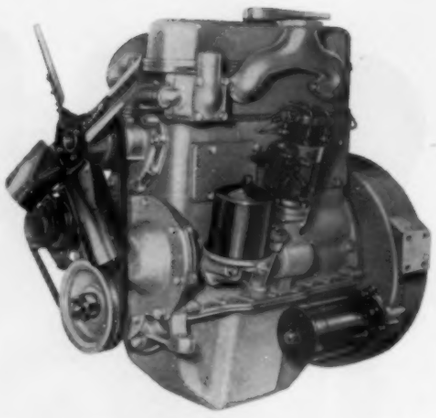
Air enters the combustion sphere tangentially, developing a revolving motion at relatively high velocity, being about 50 times the revolving speed of the crankshaft regardless of whether the engine is running slow or fast. (see the chart of air velocity versus piston motion Fig. 7) Thus at 2,000 rpm engine speed the air revolves approximately 100,000 times a minute. It is into this highly turbulent air that the fuel spray is injected and even a course fuel droplet is atomized.



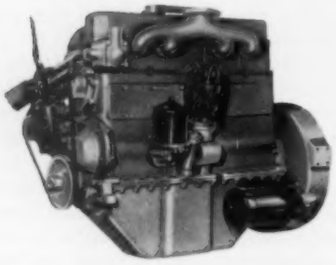
Hercules Model DIX6-272 six-cylinder turbulence chamber diesel replacement engine. Available in a complete power package for installation in Ford Trucks. This engine is equipped with the new single cylinder type fuel pump. Other four and six-cylinder diesel replacement engines are also available for Ford and Chevrolet trucks.

It can readily be understood that this type of combustion system allows operation of the Hercules Diesel over a wide spread range and insures utmost reliability in service since a self-cleaning, pintle type of fuel injection nozzle is used with injection pressures of only 1650 to 2000 p.s.i. This type of nozzle is not likely to become inoperative.

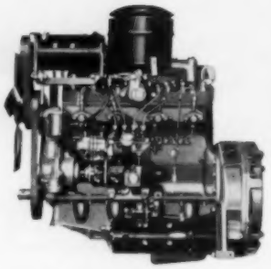
In the direct-injection type of diesel engine, a mexican-hat-type combustion space is provided in the crown of the piston. (See cross sections in Fig. 4 and Fig. 6). The air inlet ports are designed especially to create a certain amount of turbulence and make the engine as flexible as possible with utmost economy and mean effective pressures as high as 115 p.s.i. (See chart, Fig. 8, giving specific fuel consumption as a function of engine speed and load.)



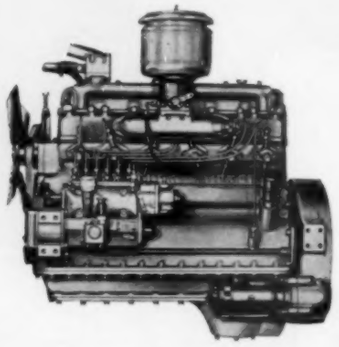
Hercules Model, D.D. 198, four-cylinder direct-injection Diesel equipped for installation in a road roller.



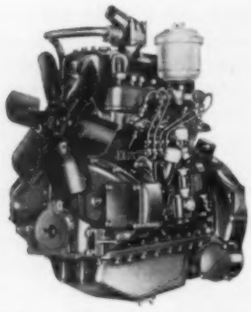
Hercules Model D.D. 298, six-cylinder Direct-Injection Diesel.



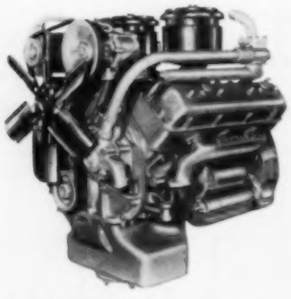
Hercules Model DOO, four-cylinder turbulence-chamber Diesel.



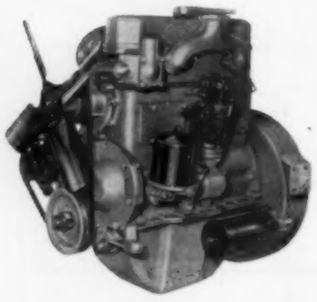
Hercules Model DIX-6D, six-cylinder turbulence-chamber Diesel.



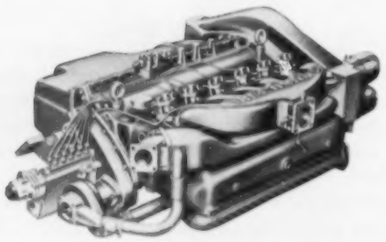
Hercules Model DIX-4, four-cylinder turbulence-chamber Diesel.



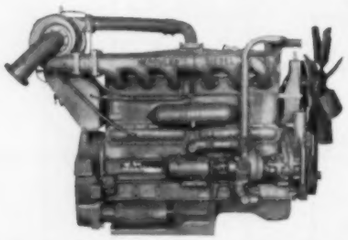
Hercules Model DIX-V8-402, eight-cylinder, VEE-type turbulence-chamber Diesel.



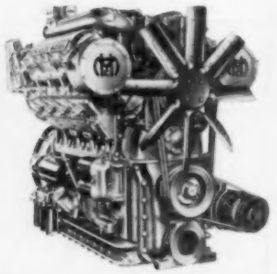
Hercules Model D.D. 198, four-cylinder Direct-injection Diesel.



Hercules Model DWXLD-F, six-cylinder, flat type turbulence-chamber Diesel.



Hercules Model TCD-985, six-cylinder turbo-supercharged turbulence-chamber Diesel.



Hercules Model DNX-V8, eight-cylinder VEE-type turbulence-chamber Diesel.

A multiple-hole or orifice type of nozzle is used for direct-injection which distributes the fuel evenly in the air rotating within the combustion space. This type of combustion system, while limited in speed range (the maximum full load speed of the direct injection engine is limited to 2000 rpm) secures the highest fuel economy and provides easy starting.

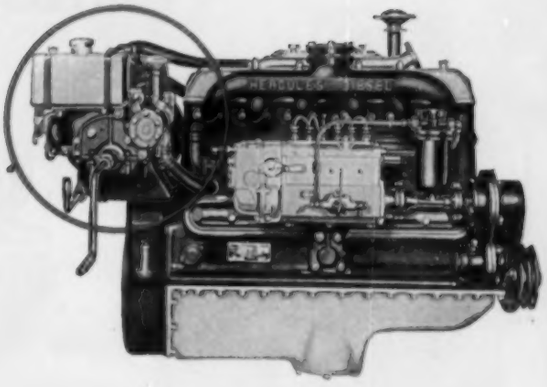


Figure 9
Hercules Diesel Engine equipped with a gasoline cranking engine.

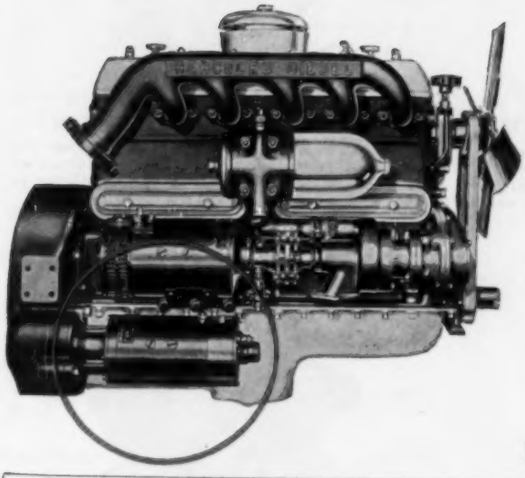


Figure 10
Hercules Diesel Engine equipped with an electric cranking motor.

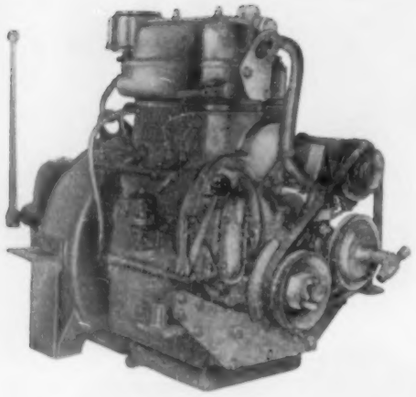
Figure 11
Hercules Diesel Engine equipped with a compressed air cranking motor.

HERCULES DIESELS

Model	Cycle	H.P.	Cyls.	Bore	Stroke	R.P.M.	Length Bell-housing Face to Fan	Length Bellhousing Face to Front Support	Height Crankshaft To Top of Cyl. Head Cover	Width Overall	Approx. Weight See Note	Fuel Injection System	S	M	Both A/P	Starting
DIX-42	4	12	1	3⅛	4	2200						Bosch-Roosa	Yes	Yes	Yes	H-E-AS
DIX-83	4	24	2	3⅛	4	2200	21 5/16"	21 3/16"	19"	21 11/16"	400	Bosch-Roosa	Yes	Yes	Yes	H-E-AS
DIXC	4	26	2	4	4½	1800	23 7/16"	19 5/16"	21"	19¾"	550	Bosch-Roosa	Yes	Yes	Yes	H-E-AS
DIXD	4	30	2	4¼	4½	1800	23 7/16"	19 5/16"	21"	19¾"	550	Bosch-Roosa	Yes	Yes	Yes	H-E-AS
DD-130	4	35.5	3	3½	4½	2000	26 13/16"	20 7/16"	20 1/16"	22 5/16"	550	Bosch-Roosa	Yes	Yes	Yes	E-AS
DD-149	4	40.5	3	3¾	4½	2000	26 13/16"	20 7/16"	20 1/16"	22 5/16"	550	Bosch-Roosa	Yes	Yes	Yes	E-AS
DIX4B	4	45.5	4	3¼	4	3000	29 11/16"	30 5/16"	19"	21 11/16"	600	Bosch-Roosa	Yes	Yes	Yes	H-E-AS
DD-169	4	46	3	4	4½	2000	26 13/16"	20 7/16"	20 1/16"	22 5/16"	550	Bosch-Roosa	Yes	Yes	Yes	E-AS
DD-173	4	49.7	4	3½	4½	2000	31 13/16"	25 5/16"	20 1/16"	22⅛"	600	Bosch-Roosa	Yes	Yes	Yes	H-E-AS
DD-198	4	57	4	3¾	4½	2000	31 13/16"	25 5/16"	20 1/16"	22⅛"	600	Bosch-Roosa	Yes	Yes	Yes	H-E-AS
DIX4D	4	57	4	3⅞	4	3000	29 13/16"	30 5/16"	19"	21 11/16"	600	Bosch-Roosa	Yes	Yes	Yes	H-E-AS
DOOB	4	62	4	3¾	4½	2600	32 1/16"	29¼"	19¾"	22¼"	750	Bosch-Roosa	Yes	Yes	Yes	E-AS
DD-226	4	65	4	4	4½	2000	31 13/16"	25 5/16"	20 1/16"	22⅛"	600	Bosch-Roosa	Yes	Yes	Yes	H-E-AS
DOOC	4	70	4	4	4½	2600	32 1/16"	29¼"	19¾"	22¼"	750	Bosch-Roosa	Yes	Yes	Yes	E-AS
DD-260	4	75	6	3½	4½	2000	40 7/16"	33 13/16"	20 1/16"	22⅛"	750	Bosch-Roosa	Yes	Yes	Yes	E-AS
DOOD	4	79	4	4⅛	4½	2600	32 1/16"	29¼"	19¾"	22¼"	750	Bosch-Roosa	Yes	Yes	Yes	E-AS
DD-298	4	85	6	3¾	4½	2000	40 7/16"	33 13/16"	20 1/16"	22⅛"	750	Bosch-Roosa	Yes	Yes	Yes	E-AS
DIX6D	4	93	6	3⅝	4	3000	38 1/16"	38 1/16"	19"	23½"	800	Bosch-Roosa	Yes	Yes	Yes	E-AS
DIX6-272	4	87	6	3 11/16	4¼	3000	38 1/16"	38 1/16"	19¼"	23½"	800	Bosch-Roosa	Yes	Yes	Yes	E-AS
DJXB	4	77	6	3½	4½	2600	39"	36 3/16"	20⅛"	22 5/16"	950	Bosch-Roosa	Yes	Yes	Yes	E-AS
DJXC	4	83	6	3¾	4½	2600	39"	36 3/16"	21"	22 5/16"	950	Bosch-Roosa	Yes	Yes	Yes	E-AS
DD-339	4	99	6	4	4½	2000	40 7/16"	33 13/16"	20 1/16"	22⅛"	750	Bosch-Roosa	Yes	Yes	Yes	E-AS
DJXH*	4	99	6	3¾	4½	2600	39"	36 3/16"	20⅛"	22 5/16"	950	Bosch-Roosa	Yes	Yes	Yes	E-AS
DJXHF	4	99	6	3¾	4½	2600	.....	38¼"	13x10 7/16"	34"	950	Bosch-Roosa	Yes	Yes	Yes	E-AS
DWXC	4	120	6	4	4¾	2600	44 3/16"	40¾"	24"	27"	1350	Bosch-Roosa	Yes	Yes	Yes	E-GE-AS
DWXD	4	135	6	4¼	4¾	2600	44 3/16"	40¾"	24"	27"	1350	Bosch-Roosa	Yes	Yes	Yes	E-GE-AS
DWXLD	4	142	6	4¼	5	2600	44 3/16"	40¾"	24⅛"	27"	1350	Bosch-Roosa	Yes	Yes	Yes	E-GE-AS
DWXLDF	4	142	6	4¼	5	2600	.....	46 7/16"	8¾x8"	39 7/16"	1325	Bosch-Roosa	Yes	Yes	Yes	E-AS
DRXB	4	133	6	4⅜	5¼	2200	46 3/16"	44¾"	24 7/16"	26 1/16"	1600	Bosch	Yes	Yes	Yes	E-GE-AS
DRX-501	4	139	6	4½	5¼	2200	46 3/16"	44¾"	24 7/16"	26 1/16"	1600	Bosch-Roosa	Yes	Yes	Yes	E-GE-AS
TCD-501	4	180	6	4½	5¼	2000	50 5/16"	44¼"	24 7/16"	27 1/16"	2000	Bosch	Yes	Yes	Yes	E-GE-AS
DRXC	4	147	6	4⅝	5¼	2200	46 3/16"	44¾"	24 7/16"	26 1/16"	1600	Bosch-Roosa	Yes	Yes	Yes	E-GE-AS
DFXB	4	190	6	5	6	2100	61¾"	55½"	30½"	30⅝"	2500	Bosch-Roosa	Yes	Yes	Yes	E-GE-AS
DFXC	4	204	6	5¼	6	2100	61¾"	55½"	30½"	30⅝"	2500	Bosch-Roosa	Yes	Yes	Yes	E-GE-AS
DFXD	4	217	6	5½	6	2100	61⅜"	55½"	30½"	30⅝"	2500	Bosch-Roosa	Yes	Yes	Yes	E-GE-AS
DFXE	4	228	6	5⅝	6	2100	61¾"	55½"	30½"	30⅝"	2500	Bosch-Roosa	Yes	Yes	Yes	E-GE-AS
TCD-895	4	304	6	5⅜	6	2000	61¾"	55½"	30½"	28"	2700	Bosch-Roosa	Yes	Yes	Yes	E-AS
DFXH*	4	260	6	5¾	6	2100	61⅜"	55½"	31 13/16"	30"	2600	Bosch-Roosa	Yes	Yes	Yes	E-GE-AS
DFXHF	4	260	6	5¾	6	2100	.....	50 5/16"	17¼x14⅝"	48 5/16"	2600	Bosch-Roosa	Yes	Yes	Yes	E-AS
DNXV8D	4	400	8	6¼	6	2100	56⅝"	50½"	31¾"	42"	4200	Bosch	Yes	Yes	Yes	E-AS
TCD-1468	4	500	8	6¼	6	2000	67"	50½"	31⅝"	42"	5000	Bosch	Yes	Yes	Yes	E-AS

S—Stationary. M—Marine. A—Automotive and/or P—Portable. E—Electric. GE—Gas Engine. H—Hand. AS—Air Starting *—Special high output heads.
Note—: Weight—With fuel handling equipment only. Weights do not include starter, generator, air cleaner, fan and other accessories not forming an integral part of the engine. Various timing arrangements, flywheel housings, oil pans, manifolds, starting motor and generator locations are available to meet specific application requirements.

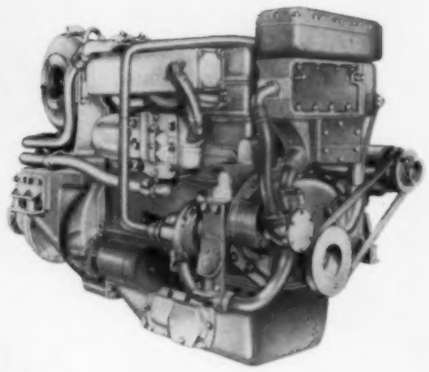
HERCULES MARINE DIESEL ENGINES



MODEL DIX-2DM

30 Rated Horsepower 2 Cyl. 900 Lbs.

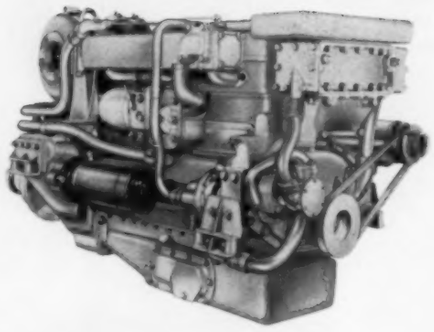
The Model DIX-2DM is a naturally-aspirated two cylinder marine diesel engine of compact size. This engine is a 2-cylinder version of the DIX4 and DIX6 series. Many of these engines are being used by the Armed Forces as auxiliary power and stand-by units.



MODEL TCD-188M

105 Rated Horsepower 4 Cyl. 950 Lbs.

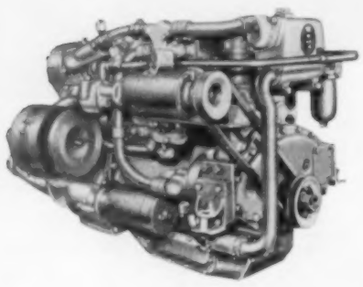
This Turbo-charged Diesel is one of the newest additions to the Hercules line. The TCD-188M provides maximum horsepower in a minimum space and is adaptable for installation as a single propulsion unit or in pairs.



MODEL TCD-283M

160 Rated Horsepower 6 Cyl. 1440 Lbs.

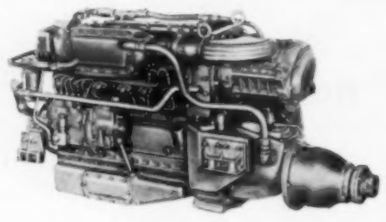
The new TCD-283M is one of the most compact engines in its power class. The lightweight feature of this engine is especially beneficial for installation in pleasure boats and workboats.



MODEL DIX-4ESM

95 Rated Horsepower 4 Cyl. 990 Lbs.

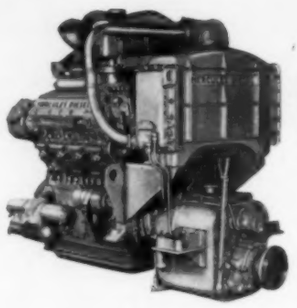
The Supercharged Model DIX-4ES is designed for rugged, heavy-duty service in the pleasure craft field as well as work boats. Like all other Hercules Marine Diesels, this model is adaptable for installation in pairs or as a single propulsion unit.



MODEL DIX-6ESM

150 Rated Horsepower 6 Cyl. 1490 Lbs.

The supercharged Model DIX-6ESM is an ideal size unit for many types of marine service-propulsion, stand-by, etc. Its compact size also permits installation in the same space required by engines of less horsepower.



MODEL TCD-1468M

265 Rated Horsepower 8 Cyl. (Vee Type) 6300 Lbs.

The Turbo-charged Diesel Model TCD-1468M is the largest model in Hercules Marine line. Its precision construction assures top performance in many types of installations such as workboat propulsion units and stand-by or auxiliary equipment in larger ships.

Model	Cycle	Cyl.	Bore	Stroke	Displ.	H.P.	R.P.M.	Length	Width Overall	Height Above*	Approx. Wt.
DIX2DM	4	2	4¼	4	127.5	30	1800	36¾	25¾	21¾	900
DIX-4EM	4	4	3⅞	4	188	75	3000	47⅛	29 1/16	20	890
DIX-4ESM	4	4	3⅞	4	188	95	3000	47⅛	29 1/16	21	990
TCD-188M	4	4	3⅞	4	188	105	3000	46¾	27 13/16	22⅞	950
DIX-6EM	4	6	3⅞	4	283	115	3000	55¼	28¼	22⅞	1380
DIX-6ESM	4	6	3⅞	4	283	150	3000	55¼	27 13/16	22⅞	1490
TCD-283M	4	6	3⅞	4	283	160	3000	55¼	27 13/16	22⅞	1440
TCD-895M	4	6	5⅝	6	895	318	2000	88	37⅝	35½	4500
DFXHM	4	6	5¼	6	935	260	2100	88	37⅝	35½	4230
DNX-V8DM	4	8	6¼	6	1468	255	1200	83 5/16	49⅜	50 1/16	7400
TCD-1468M	4	8	6¼	6	1468	265	1200	83 5/16	49⅜	50 1/16	7740

* Includes Reduction Gear. TCD—Turbocharged S—Mech. Supercharged

INDUSTRIAL AND MARINE DIESEL ENGINES AND ELECTRIC SETS

CATERPILLAR

FOR more than a quarter century Caterpillar Tractor Co. has designed and manufactured modern, heavy-duty diesel engines. These engines are provided as industrial power units, electric sets, marine propulsion engines, arc-welders and torque converter power units. Spark-ignition engines can be provided for applications in which low cost natural gas is available. Cat diesel engines are used as original or replacement power for excavators, cranes, ditchers, asphalt plants, crushers, compressors, pumps, drill rigs, sawmills and other equipment.

All Caterpillar engines are of the four-cycle design which permits a long effective power stroke and efficient utilization of fuel during combustion. Of the twelve models offered, eight are used to power the tractors and motor graders built by Caterpillar. The line includes a choice of engines ranging up to 650 hp (maximum output capacity). Electric sets are available in sizes up to 350 kw. These engines are used by other manufacturers to power the machines they build. To adapt them to specific applications and requirements there is a wide choice of attachments.

Basic design features of all Cat engines are sufficiently similar to describe them as a group. The Vee-type engines offer additional advantages in that they may be modified for either clockwise or counterclockwise rotation, and the total horsepower output may be taken from either end of the crankshaft.

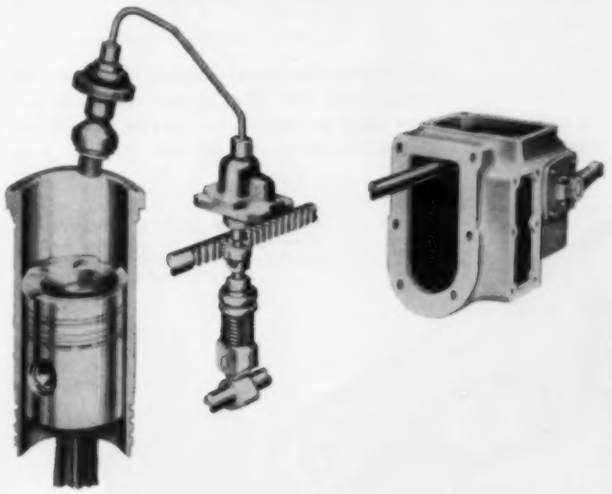
THE CATERPILLAR FUEL INJECTION SYSTEM permits the engine to operate on a variety of low-cost, high heat content fuels, as well as on the usual premium quality diesel fuels. All Cat engines use a small capsule-type injection valve of the single orifice design.

Fuel injection pumps and valves are interchangeable and are free of adjustments or balancing. The precombustion chamber utilizes heat and pressure to mix the fuel and begin the burning process before the full charge is admitted to the cylinder. This process combined with the single orifice valve makes it possible for Cat engines to idle for extended periods without fouling, and then to pick up full load instantly.

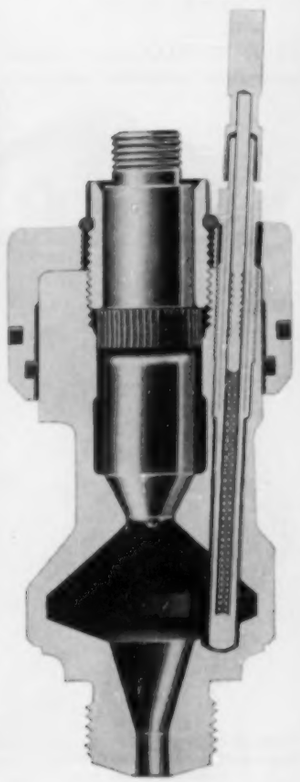
FUEL FILTERS are of the cotton yarn or plastic impregnated paper type, depending upon the engine model. These elements, which are enclosed within a dust-proof housing, provide protection for fuel injection equipment. When the fuel pressure gauge indicates it is necessary, filter elements are easily removed and inexpensively replaced.

GOVERNORS standard on Caterpillar engines are of the flyball type. Lubricated by an oil spray and sealed within a dust-proof housing, they keep the power of the engine matched to the load. For standard operation, variation in speed from full

Cat D326 (Series F) diesel engine.

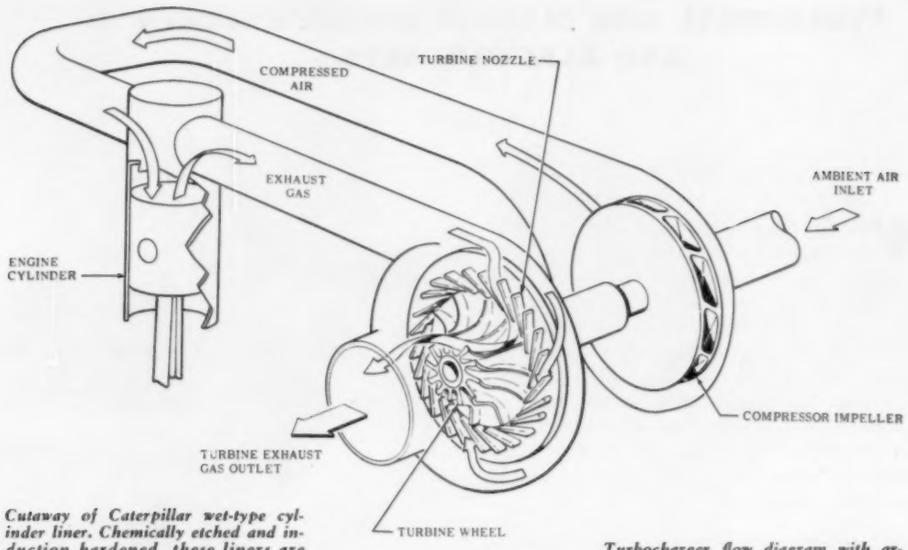


Exploded view of Caterpillar fuel system showing governor, rack, injector pump and precombustion chamber containing fuel injector.



Cutaway of the Cat diesel injector showing the single orifice injector capsule and precombustion chamber with glow plug starting aid attachment.

Cutaway of Caterpillar wet-type cylinder liner. Chemically etched and induction hardened, these liners are cooled their full length by water circulated through the block.



Turbocharger flow diagram with arrows indicating path of inlet air and exhaust gases.

load to no load allows a regulation of approximately 10 per cent. For electric set operation the variation is kept to within 3 per cent. An isochronous governor is available for applications which require exact regulation.

TURBOCHARGERS provide increased efficiency, more quiet operation and reduced fuel costs per horsepower-hour. By using otherwise wasted exhaust gas energy, the turbocharger packs more air into the cylinders, making it possible to take additional horsepower from the engine. Turbochargers are integral parts of the D337 (series F) and D353 engines. They are also available in standard arrangements of the D397, D375, D318 (series G) and D315 (series G) engines.

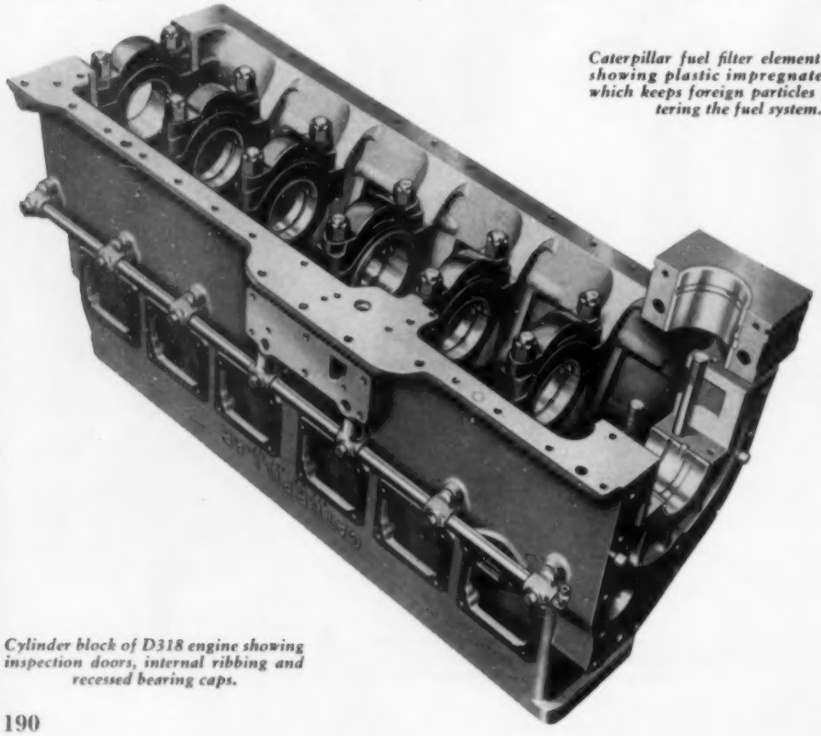
CYLINDER BLOCKS are designed for maximum strength by positioning ribs and partitions strategically to give support to all engine parts. The lower cross members are machined to permit bearing caps to be recessed within the block for additional rigidity. To facilitate inspection of internal parts without dropping the pan, each block has large inspection doors. On Vee-type engines, rods and bearings may be removed through these openings.

CYLINDER LINERS used in all Caterpillar engines are of the wet-type, water-cooled over their full length. They are "Hi-Electro" hardened and chemically etched to assure good break-in and long service.

CYLINDER HEADS are one-piece castings of high strength iron alloy. They contain large water passages which provide excellent cooling capacity and thus reduce stresses to a minium.

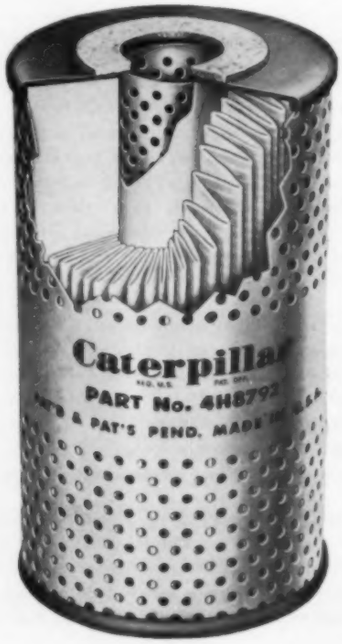
VALVE MECHANISMS are pressure lubricated and rocker arm shafts are "Hi-Electro" hardened. Dual valve springs provide positive protection against spring failure. All models except the D311, D315, D318 and the series G engines feature valve rotators which turn the valves slightly each time they are lifted. This constantly changing relationship of valve and seat retards carbon build-up and valve and seat burning. The larger engines also have replaceable valve seat inserts and valve guides.

CRANKSHAFTS are drop-forged from high carbon steel and rifle-drilled for oil passage. To provide an extremely hard bearing surface, journals are "Hi-Electro" hardened to a uniform depth of $\frac{1}{8}$ inch. The remainder of each shaft is left tough to permit torsional shock absorption. A superfinishing process polishes all bearing surfaces to an extremely fine smoothness. And, to assure a



Cylinder block of D318 engine showing inspection doors, internal ribbing and recessed bearing caps.

Caterpillar fuel filter element cutaway showing plastic impregnated paper which keeps foreign particles from entering the fuel system.



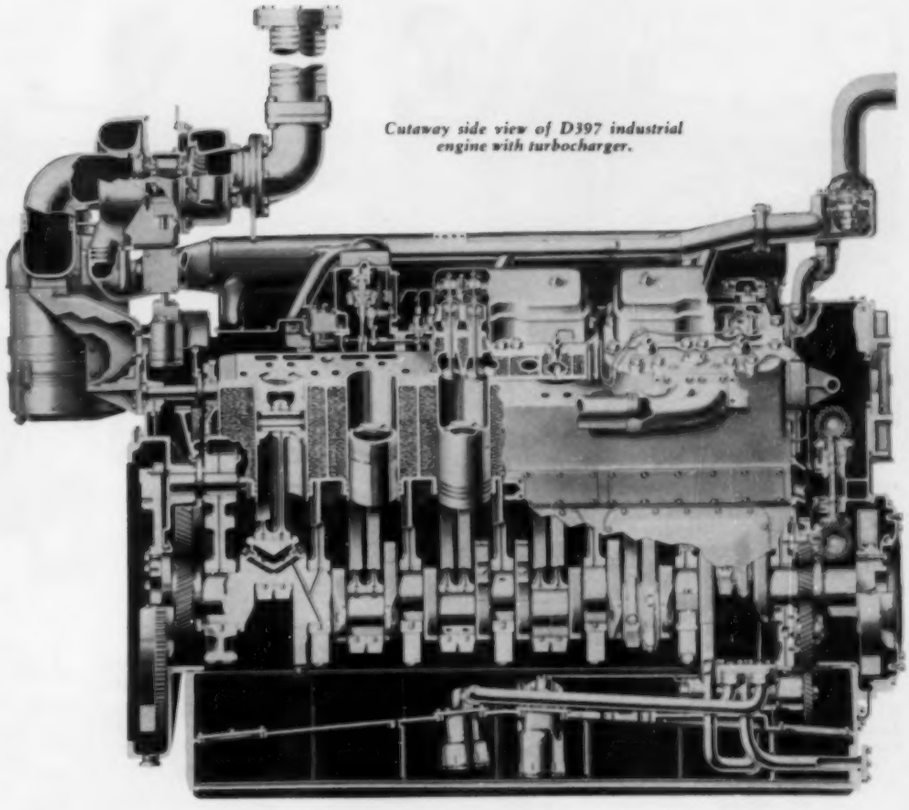
defect-free part, each crankshaft is given a Magnaflux test.

PRECISION-TYPE BEARINGS used in all Caterpillar engines are made of aluminum alloy. To afford proper break-in, each bearing is given a thin plating of tin. Aluminum alloy bearings have the ability to transfer heat rapidly and are not affected by normal engine acids. These bearings have high load carrying ability, wear resistance and high fatigue strength. On all engine models, either the center or rear main bearing is flanged to absorb longitudinal thrust.

ALUMINUM ALLOY PISTONS are precision finished and balanced. The top compression ring is carried in a cast iron ring band which greatly adds to the piston life. Most rings are hard chrome-faced for long service life of the rings and liners. Piston pins are of the full-floating type, connecting rods are machined from drop forged steel with H-section shanks and piston pin bushings are made of precision bored steel-backed bronze.

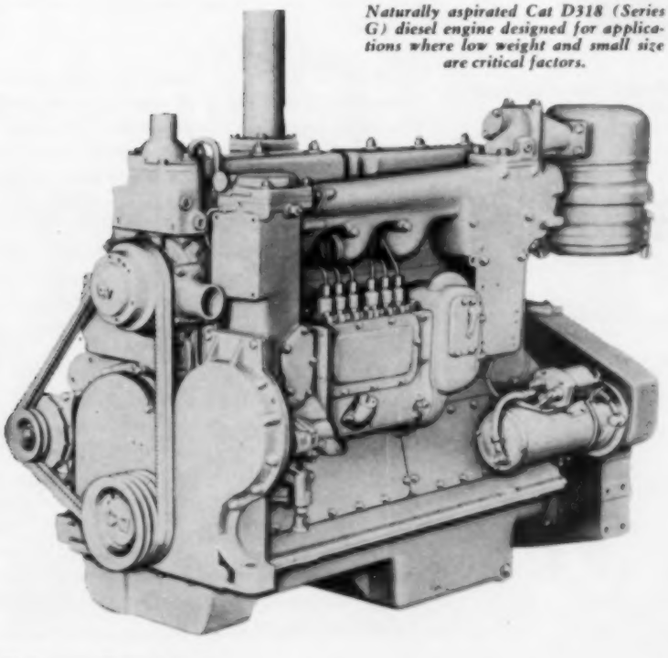
LUBE OIL SYSTEM provides full flow pressure lubrication to all moving parts. The gear-type lube oil pump is designed with extra capacity. It assures positive pressure lubrication at all times and requires a minimum of maintenance.

LUBE OIL FILTERS provide complete filtering of oil as it circulates through the engine. These filters, which are of the plastic impregnated paper type, remove even the microscopically small particles that endanger engine parts. Their large capacity permits extended periods between changes. Should they become clogged, an automatic arrangement allows oil to by-pass the filters and thus protect the engine from possible lube oil starvation.

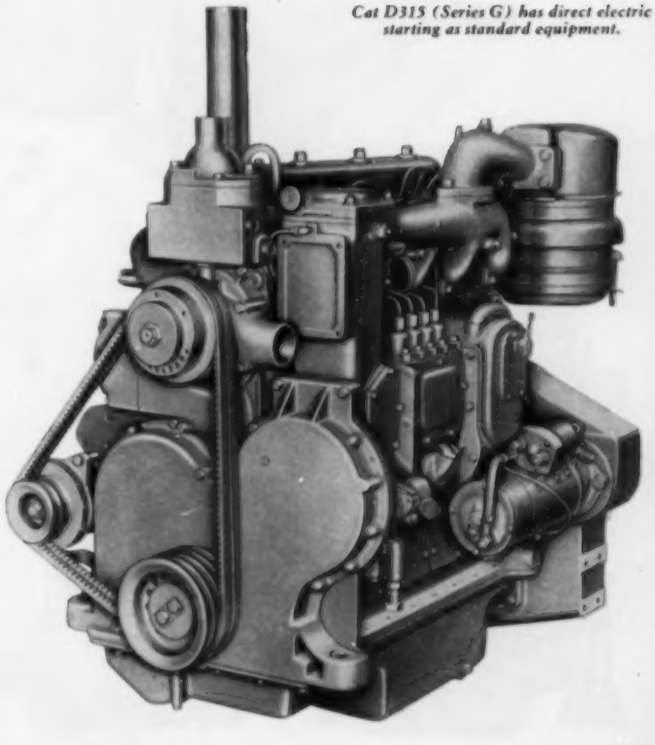


Cutaway side view of D397 industrial engine with turbocharger.

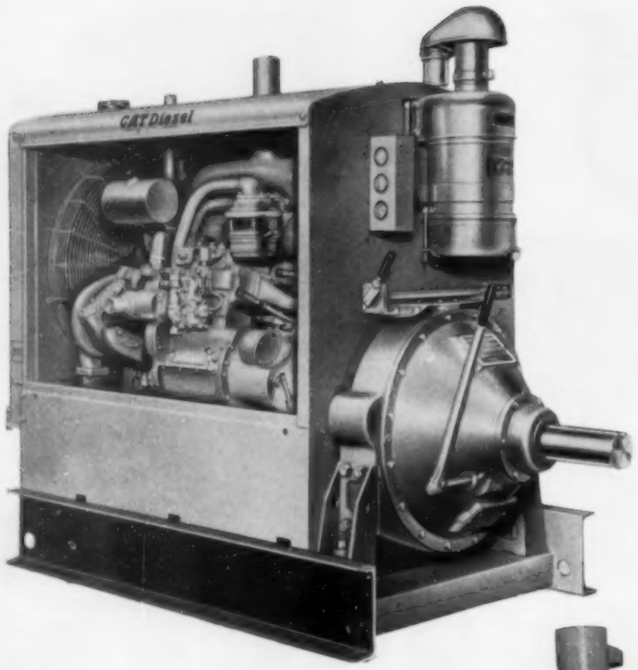
COOLING SYSTEMS vary according to the type of engine application. Caterpillar offers several systems designed to fit individual requirements. On engine installations where raw water is avail-



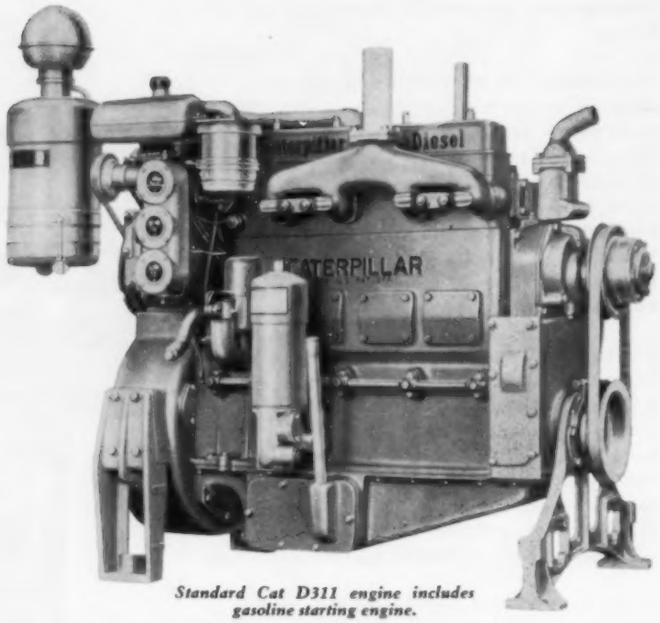
Naturally aspirated Cat D318 (Series G) diesel engine designed for applications where low weight and small size are critical factors.



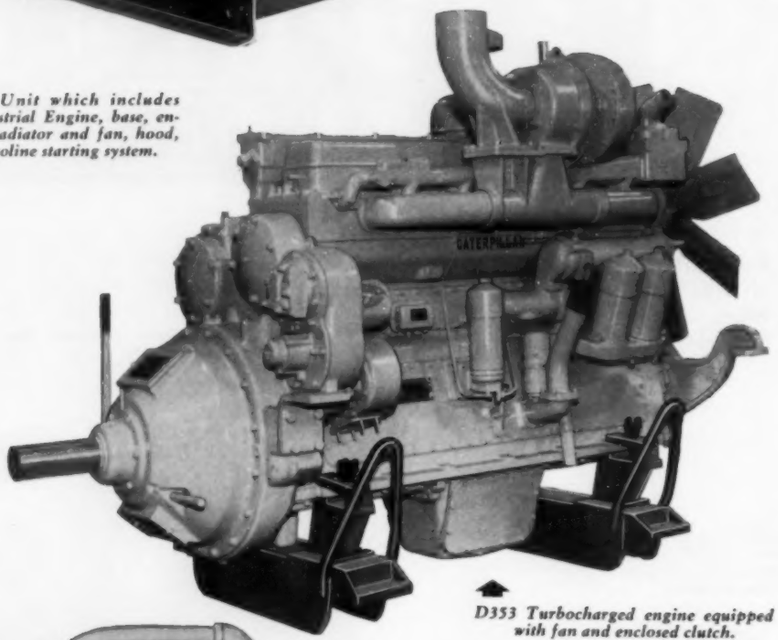
Cat D315 (Series G) has direct electric starting as standard equipment.



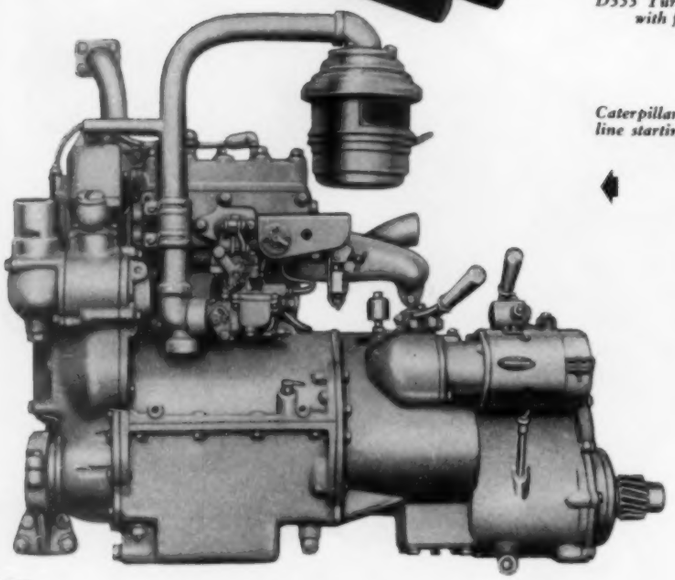
D339 Power Unit which includes Standard Industrial Engine, base, enclosed clutch, radiator and fan, hood, dash and gasoline starting system.



Standard Cat D311 engine includes gasoline starting engine.



D353 Turbocharged engine equipped with fan and enclosed clutch.



Caterpillar two-cylinder vertical gasoline starting engine with electric starting motor.

able, heat exchanger cooling is generally desired. This particular cooling system is not affected by ambient air temperatures, air circulation or contaminated air. Where ambient air temperatures do not exceed 110° F and where the flow of air to and from the radiator is unrestricted, a standard radiator is generally satisfactory. Marine engines have closed systems employing both fresh and raw water pumps and heat exchangers.

SPECIALLY DESIGNED WATER DIRECTORS are standard and provide uniform cooling which eliminates stresses within the heads. Also standard are postiive acting thermostats which regulate the flow of cooling water through the blocks. The gear-driven water pump, an integral part of the engine, has self-adjusting seals and its impeller mounts on a rust and corrosion-resistant, stainless steel shaft.

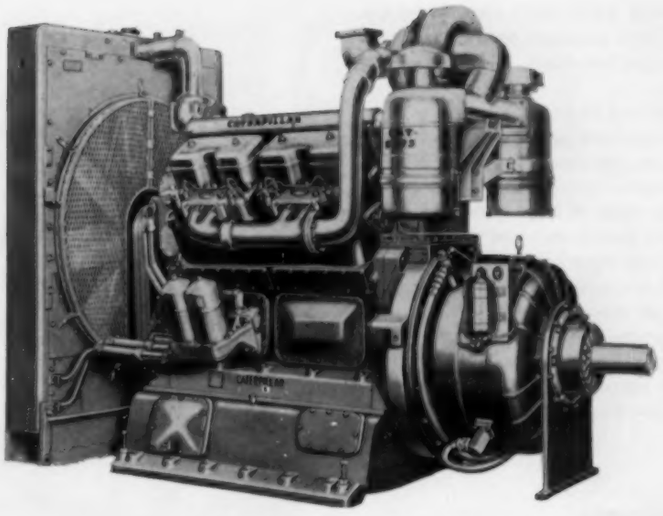
STARTING SYSTEMS must be dependable. Caterpillar offers a choice of starting systems and aids which are designed to fit specific applications. Direct electric starting of the diesel engine is often desired in installations where convenience or speed of starting is important. For installations requiring automatic start-stop, engines can be equipped with automatic controls which require no operating personnel. Other attachments are available to automatically shut down the engine in event of high water temperature or low oil pressure.

For all-weather starting the diesel engine may be equipped with a gasoline starting engine. This system preconditions the diesel and supplies lubrication before the diesel is started. Exhaust gases from the starting engine preheat the diesel engine intake air. Cooling water from the starting engine circulates through the diesel's block, imparting its warmth to the diesel engine. Electric starting for the gasoline starting engine may be added for convenience.

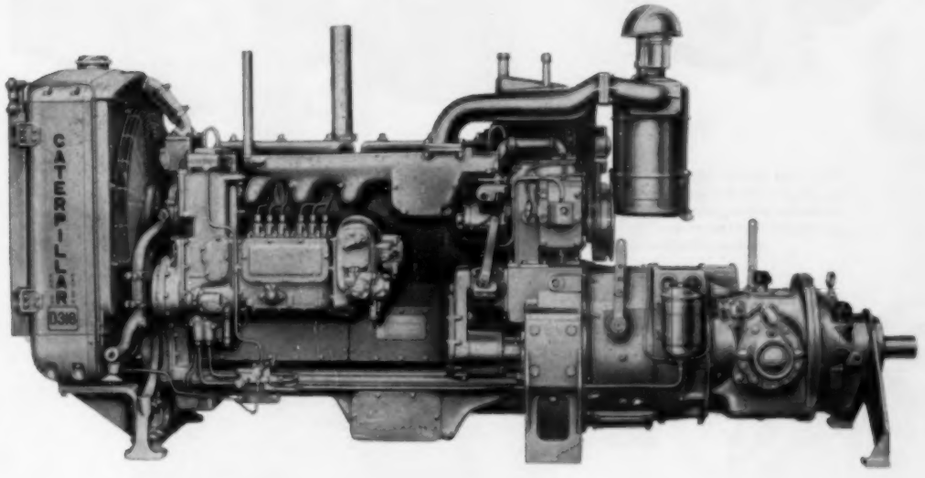
Where an air supply is readily available or where gasoline would constitute a fire hazard, speed and convenience of air starting may be desired. The air starting system includes a vane-type air motor that bolts to the flywheel housing. If an air supply is not available, matching equipment is offered to supply compressed air.

For additional starting ease, especially in cold climates, glow plugs and ether starting aids are offered as attachments.

TORQUE CONVERTERS are available for most Cat diesel engines. They offer the type of fluid drive best suited for the various forms of heavy industrial equipment which are subjected to severe load variations. Torque converters offer the advantages of rapid acceleration, a torque output matched to the load, freedom from stalling of the diesel because of overloads and smooth pick-up of heavy loads.

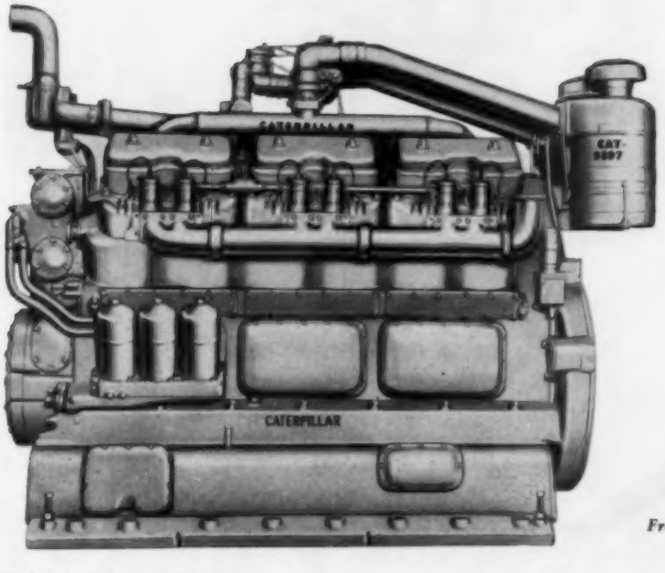


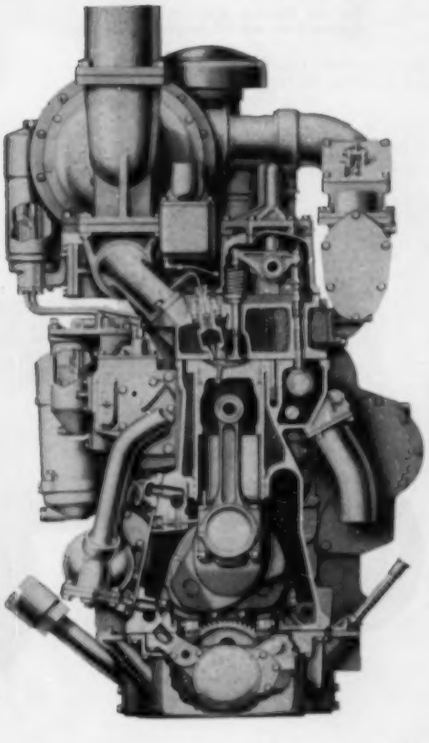
Standard D375 torque converter power unit with turbocharger.



D318 torque converter power unit. Basic arangement includes gasoline starting engine, radiator and fan, filters, gauges and fluid coolers for torque converter. Unit shown here is equipped with clutch, torque converter, reverse gear and heavy-duty stub shaft.

Cat D397 spark ignition engine.

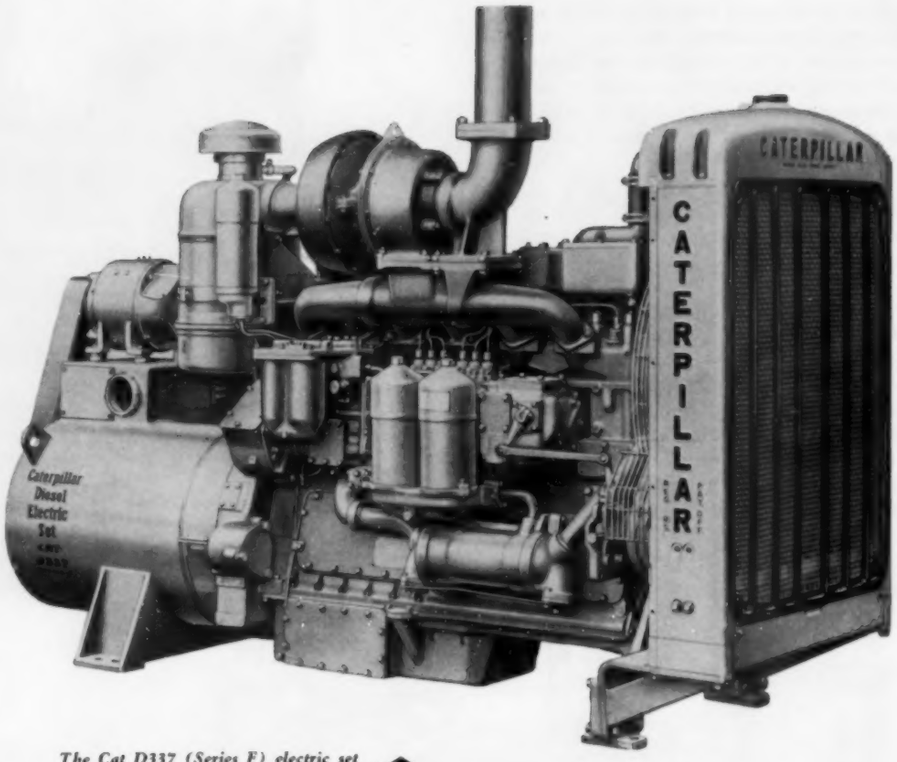




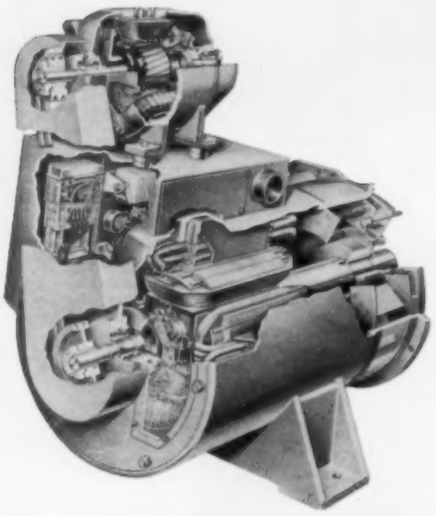
Front view cutaway of Cat D337 (Series F) diesel engine.

OTHER POWER TAKE-OFFS available for Cat diesels include fluid couplings, open and enclosed clutches, chain and belt drives.

CAT ELECTRIC SETS are completely new in design. The self-regulated constant voltage generators combine the best features of both self-regulated and externally-regulated units. These generators handle the surge of large loads, give steady voltage from no load to full load and are easily synchronized with other generators. Their compactness is due to the use of new insulating materials, elimination of waste space in the end housings and the mounting of the exciter on top the generator. Most voltages are available for either 50 or 60 cycle operation and DC generators are available for special applications.

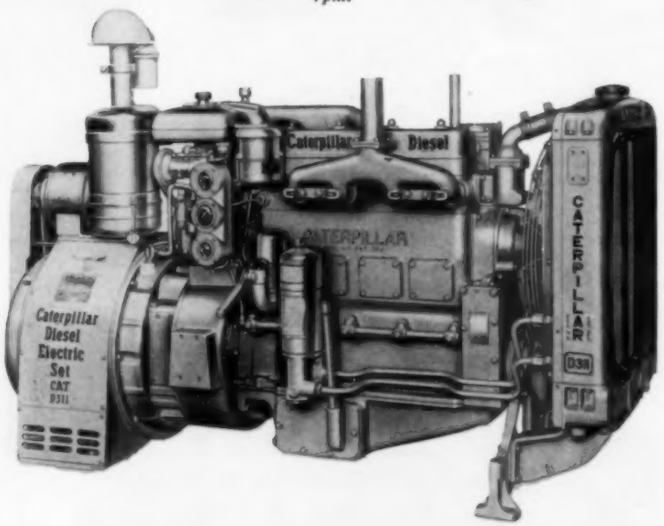


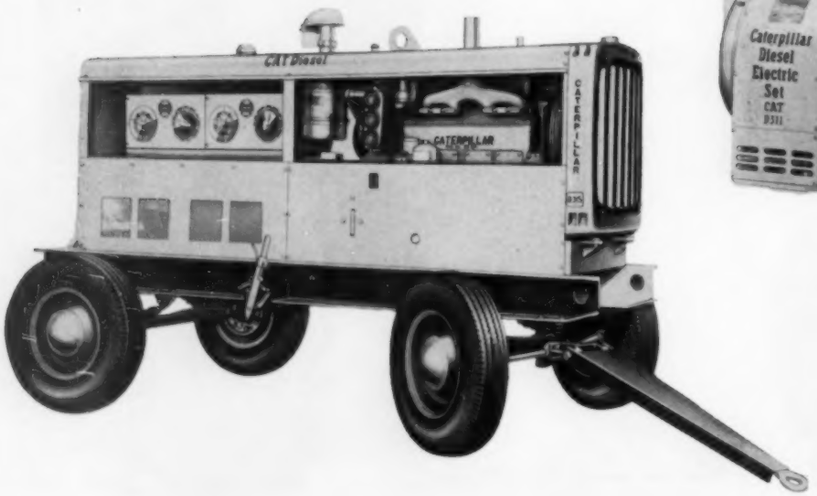
The Cat D337 (Series F) electric set produces 150 kw standard arrangement includes self-regulated constant voltage generator. Radiator and fan are available as attachments.



Cutaway of self-regulated constant-voltage generator. Regulating equipment has no moving parts and exciter is mounted on top of generator housing.

Cat D311 electric set which produces 30 kw (continuous rating) @ 1800 rpm.

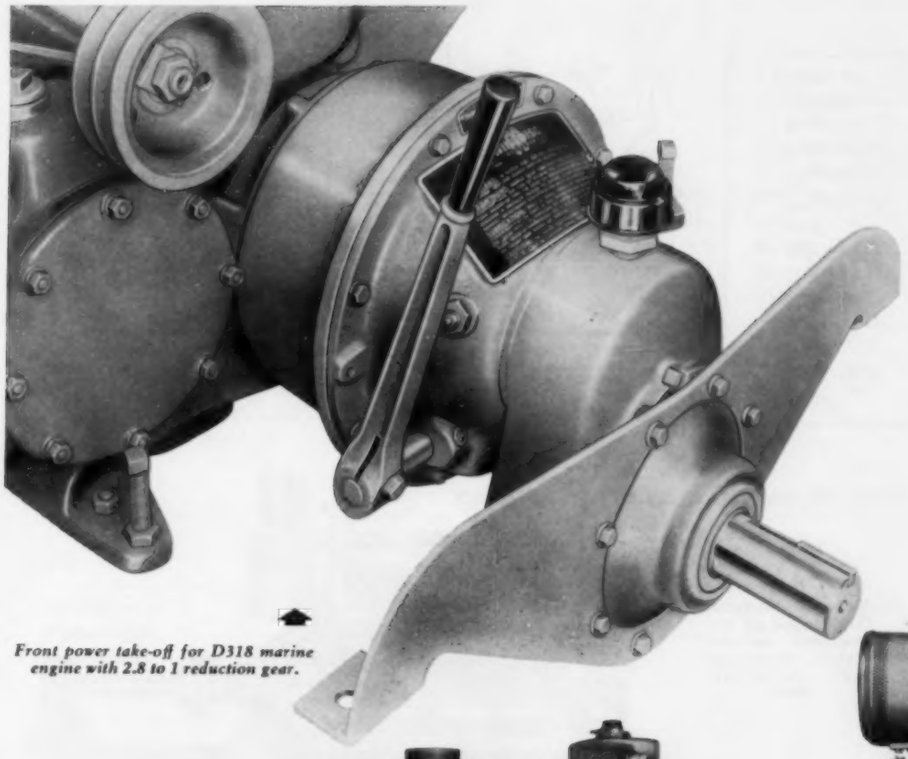




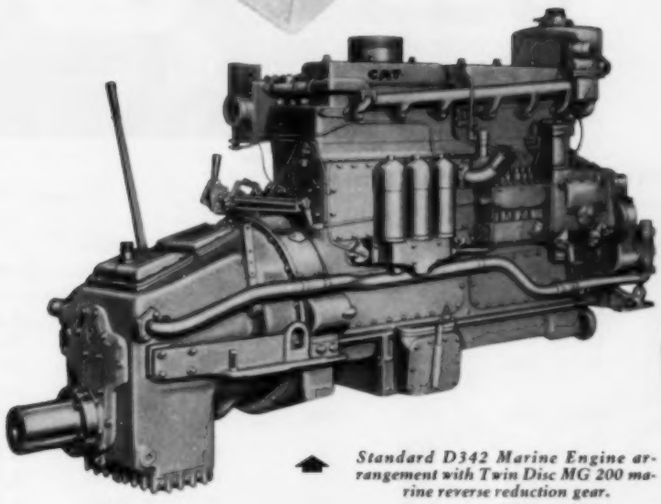
The Cat D315 portable twin arc-welder mounted on special running gear for high mobility features two 300 amp. Lincoln welding generators.

MARINE ENGINES are offered with a choice of marine reverse and reduction gear ratios. Proper rotation for right and left hand propellers are available for twin screw installations with otherwise identical engines. Attachments include a front power take-off with clutch for all marine engine models, as well as a complete line of marine engine accessories.

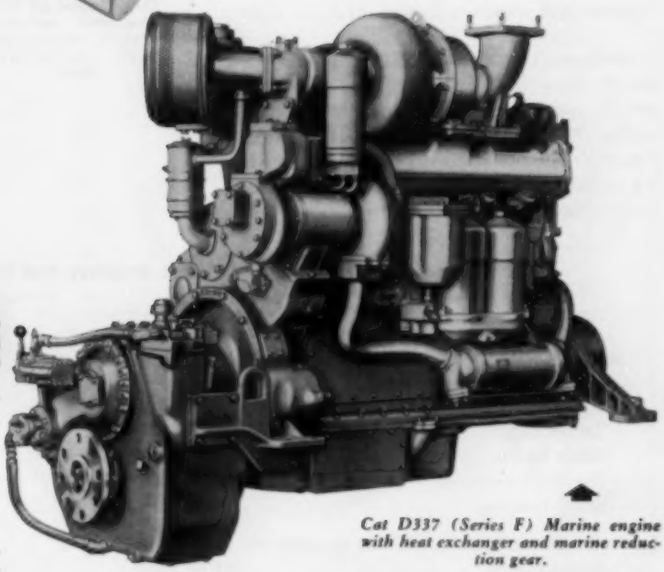
SPARK IGNITION ENGINES are available for use where natural gas can be purchased more cheaply than other fuels. The efficiency of these engines is considerably higher than normally associated with "all purpose" gas engines since the 10 to 1 compression ratio utilizes the maximum energy from methane-type natural gas.



Front power take-off for D318 marine engine with 2.8 to 1 reduction gear.



Standard D342 Marine Engine arrangement with Twin Disc MG 200 marine reverse reduction gear.



Cat D337 (Series F) Marine engine with heat exchanger and marine reduction gear.

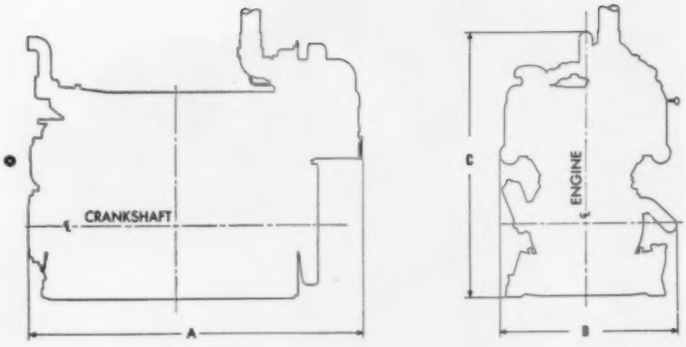
CAT DIESEL MARINE ENGINES

Model	Horsepower (Continuous)	RPM	No. Cylinders	Bore	Stroke	Weight Approx.	Starting*
D397 (Series D)							
Turbocharged	500	1225	V-12	5¾	8	16,250	A,E,G
Roots Blown	450	1225	V-12	5¾	8	16,050	A,E,G
Naturally Aspirated	360	1225	V-12	5¾	8	14,060	A,E,G
D375 (Series D)							
Turbocharged	300**	1225	V- 8	5¾	8	12,165	A,E,G
Roots Blown	300	1225	V- 8	5¾	8	12,115	A,E,G
Naturally Aspirated	235	1225	V- 8	5¾	8	11,665	A,E,G
D353 (Series C)	290	1225	6	6¼	8	8,625	A,E,G
D342	153	1225	6	5¾	8	6,905	A,E,G
D337 (Series F)	182	1600	6	5⅛	6½	4,830	A,E,G
D326 (Series F)	134	1600	6	5⅛	6½	4,470	A,E,G
D318	83	1600	6	4½	5½	3,585	A,E,G
D315	56	1600	4	4½	5½	2,710	A,E,G

*A—Air; E—Electric G—Gasoline starting engine; **Horsepower limited by marine gear.

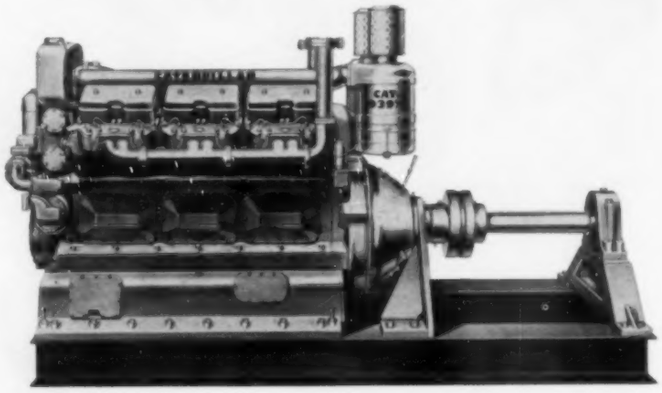
CAT INDUSTRIAL ENGINES

Model	A	B	C
D397 (Series D)	104	54	79⅛
D375 (Series D)	83⅜	54½	79⅛
D353 (Series C)	75⅜	47 9/16	69¼
D342	81	42½	62¼
D339	73½	39	65¾
D337 (Series F)	72⅜	36¾	59½
D326 (Series F)	71⅜	36¾	58¼
D318 (Series G)	60	32	42¼
D318	55⅞	32⅞	42½
D315 (Series G)	46 13/16	35⅞	55 5/16
D315	59	30	48⅜
D311	58	28	53



Both the D397 and D375 spark ignition engines have been designed to burn this low cost fuel. These engines have a low tension magneto system which feeds low tension current to the high tension transformers located near the spark plugs. High tension leads are very short in order to transmit a hot, positive spark with maximum safety.

ADDITIONAL INFORMATION concerning Cat diesel engines can be obtained from more than 800 Caterpillar dealer outlets in the United States and in 125 countries throughout the Free World. These same dealers offer complete sales and service for the entire Caterpillar line and can supply you with dependable parts you can trust.



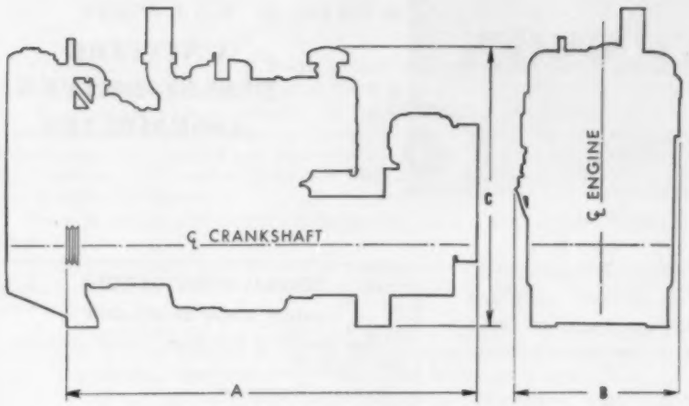
Naturally aspirated D397 cotton gin engine with enclosed clutch, extended shaft and pillow block.

CAT DIESEL ENGINES FOR STATIONARY OR PORTABLE POWER

Horsepower @ RPM

Model	Maximum Output	Intermittent	Rated	Continuous	Cylinders	Bore	Stroke	Weight Approx.	Starting*
D397 (Series D)	650 @ 1300			500 @ 1200	V-12	5¾	8		A,E,G
Turbocharged		575 @ 1300		450 @ 1200	V-12	5¾	8	11,250	A,E,G
Roots Blown		520 @ 1300		360 @ 1200	V-12	5¾	8	11,200	A,E,G
Naturally Aspirated		415 @ 1300			V-12	5¾	8	10,700	A,E,G
Spark Ignition				400 @ 1200	V-12	5¾	8	10,700	A,E,G
D375 (Series D)	430 @ 1300				V- 8	5¾	8		A,E,G
Turbocharged		383 @ 1300		325 @ 1200	V- 8	5¾	8	8,650	A,E,G
Roots Blown		350 @ 1300		302 @ 1200	V- 8	5¾	8	8,600	A,E,G
Spark Ignition				267 @ 1200	V- 8	5¾	8	8,150	A,E,G
Naturally Aspirated		275 @ 1300		238 @ 1200	V- 8	5¾	8	8,150	A,E,G
D353 (Series C)	390 @ 1300	340 @ 1200		290 @ 1225	6	6¼	8	6,525	A,E,G
D342	210 @ 1200	190 @ 1200	171 @ 1200	152 @ 1200	6	5¾	8	5,140	A,E,G
D339	140 @ 1200	126 @ 1200	112 @ 1200	100 @ 1200	4	5¾	8	3,800	A,E,G
D337 (Series F)	310 @ 2000	280 @ 2000	200 @ 1800	186 @ 1800	6	5⅛	6½	3,700	A,E,G
D326 (Series F)	200 @ 2000	184 @ 2000	155 @ 1800	137 @ 1800	6	5⅛	6½	3,550	A,E,G
D318 (Series G)									
Turbocharged	175 @ 2000	160 @ 2000	130 @ 1800	120 @ 1800	6	4½	5½	2,400	A,E
Naturally Aspirated		119 @ 2000	101 @ 1800	90 @ 1800	6	4½	5½	2,400	A,E
D318	137 @ 2000	119 @ 2000	101 @ 1800	90 @ 1800	6	4½	5½	2,770	A,E,G
D315 (Series G)									
Turbocharged	115 @ 2000	107 @ 2000	86 @ 1800	80 @ 1800	4	4½	5½	1,985	A,E
Naturally Aspirated		82 @ 2000	69 @ 1800	62 @ 1800	4	4½	5½	1,950	A,E
D315	91 @ 2000	82 @ 2000	69 @ 1800	62 @ 1800	4	4½	5½	2,200	A,E,G
D311	65 @ 2000	57 @ 2000	48 @ 1800	43 @ 1800	4	4	5	1,800	A,E,G

*A—Air; E—Electric; G—Gasoline starting engine.



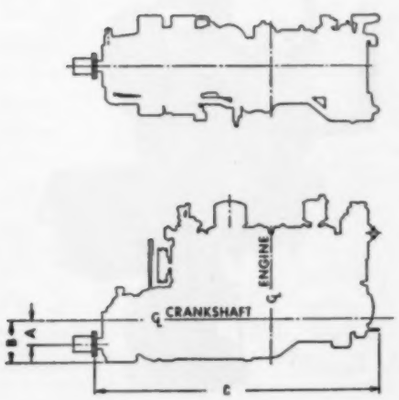
CAT ELECTRIC SETS

Electric Sets Model	A	B	C
D397 (Series D)	143 7/8	57 1/2	79 1/8
D375 (Series D)	121 3/4	52 11/16	77 1/16
D353 (Series C)	120 13/32	47 5/16	69 7/32
D342	123 3/4	41 3/4	62 1/4
D337 (Series F)	99	37	59 1/2
D326 (Series F)	94	37	58 1/4
D318	92 3/4	31 5/16	53 1/8
D318 (Series G)	87 1/2	30 13/16	42 5/16
D315	77 1/4	29 1/16	48 3/4
D315 (Series G)	72 5/8	30 13/16	41 3/16
D311	74 3/8	27 3/4	53

CAT 60-CYCLE SELF-REGULATED ELECTRIC SETS†

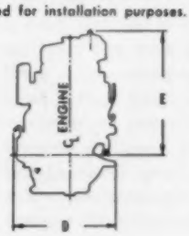
Model	KW Rating (Continuous)	RPM	No. Cylinders	Bore	Stroke	Weight Approx.	Starting*
D397 (Series D)							
Turbocharged	350	1200	V-12	5 3/4	8	16,000	A,E,G
Roots Blown	315	1200	V-12	5 3/4	8	15,900	A,E,G
Naturally Aspirated	250	1200	V-12	5 3/4	8	15,450	A,E,G
D375 (Series D)							
Turbocharged	225	1200	V- 8	5 3/4	8	12,250	A,E,G
Roots Blown	200	1200	V- 8	5 3/4	8	12,200	A,E,G
Naturally Aspirated	165	1200	V- 8	5 3/4	8	11,750	A,E,G
D353 (Series C)	200	1225	6	6 1/4	8	9,875	A,E,G
D342	100	1200	6	5 3/4	8	7,640	A,E,G
D337 (Series F)	150	1800	6	5 1/8	6 1/2	6,200	A,E,G
D326 (Series F)	100	1800	6	5 1/8	6 1/2	5,600	A,E,G
D318 (Series G)							
Turbocharged	75	1800	6	4 1/2	5 1/2	3,980	A,E
Naturally Aspirated	60	1800	6	4 1/2	5 1/2	3,700	A,E
D318	60	1800	6	4 1/2	5 1/2	3,750	A,E,G
D315 (Series G)							
Turbocharged	50	1800	4	4 1/2	5 1/2	3,335	A,E
Naturally Aspirated	40	1800	4	4 1/2	5 1/2	3,215	A,E
D315	40	1800	4	4 1/2	5 1/2	3,200	A,E,G
D311	30	1800	4	4	5	2,600	A,E,G

†50-cycle and DC units are also available; A—Air; E—Electric; G—Gasoline starting engine.



EACH GEAR IS AVAILABLE IN EITHER RH OR LH ROTATION

NOTE: General dimension drawings are available at factory and should be used for installation purposes.



CAT MARINE ENGINES

Marine Engines Model	A	B	C	D	E
D397 (Series D)	14 3/8	28 3/4	151 3/4	55 1/16	55 11/16
D375 (Series D)	15 1/4	29 5/16	129 1/2	55 1/16	55 11/16
D353 (Series C)	11	22 7/8	117 1/2	42 5/8	48 3/4
D342	11 1/16	20 1/2	110 1/16	41 3/16	49 1/4
D337 (Series F)	9 5/16	19 1/16	75 7/16	44	45 5/8
D326 (Series F)	8 1/4	16 1/4	80 7/8	44	45 5/8
D318	8 5/8	16 1/8	86 7/16	31 3/4	35
D315	7	13 1/8	69 7/8	30 5/8	34 5/8

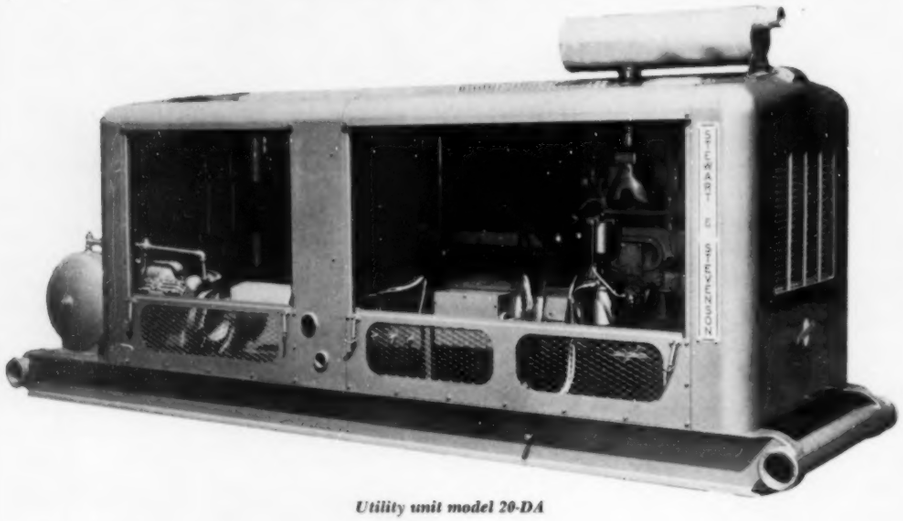
STEWART & STEVENSON SERVICES

UNITIZED DIESEL-DRIVEN ASSEMBLIES

Stewart & Stevenson, Inc., manufacturers a complete line of mobile generator sets, pumping units, utility units and similar equipment. There is specialized equipment available for almost every kind of application.

In general Stewart & Stevenson assemblies are distinguished by their conservative rating and rugged construction. They are engineered units and as a result are unusually compact, convenient and trouble free.

DIESEL-DRIVEN UTILITY UNITS



Utility unit model 20-DA

Here is a completely new series of all-electric utility units that eliminate the many service difficulties commonly associated with mechanically-driven units. The Stewart & Stevenson Model 20 DA utility unit illustrated, is a completely self-contained unit consisting of a diesel driven 20 Kilowatt lighting generator, a centrifugal water pump, air compressor and if desired, a built-in electric welder. The 20 Kilowatt generator which can be furnished either AC or DC is connected direct to the engine and supplies current for operation of the electric motor, that drives all the component accessories.

This system provides many advantages over the conventional mechanical drive. It eliminates the necessity of the line shaft, pillow-blocking bearing, flexible couplings and line shaft clutches which require lubrication alignment and other troublesome maintenances familiar to all of those who have had experience with such equipment.

On the new Stewart & Stevenson all-electric utility units, the accessories are individually driven by splash-proof ball bearing electric motors of standard make. These motors are capable of operating for many years with practically no attention. Therefore, it is easy to see that maintenance difficulties characteristic of line shaft couplings, bearings, etc., are eliminated. This arrangement also gives extra flexibility since the speed of components such as the centrifugal pump can be varied without changing engine speed or interfering with the lighting operation.

The idea of electric-driven components for utility units is not new. However, such units have been expensive and generally the first cost has been too great to justify their use by the average user. On the other hand the Stewart & Stevenson all-electric utility units, with their many advantages cost no more than conventional mechanically driven units. This low cost is made possible without any sacrifice in quality by careful design and mass production methods.

GENERAL SPECIFICATIONS

MODEL 20-DA UTILITY UNIT

Power-Model 2-71 GM Diesel Engine operating at 1450 RPM.

Standard Equipment

20 KW DC Lighting Generator
17 cu. ft. iar compressor-elec. Motor driven.
40 gal. air tank
30 gal. fuel oil tank
1½" washdown pump, 150 GPM @ 90 psi electric motor driven.

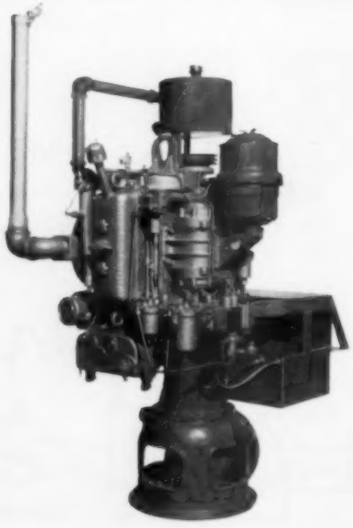
This model (new) 20-DA combination unit is completely self-contained and mounted on a steel type sub-base, with sheet-metal, weather resistant enclosure. Elec. motors are manual starting. Speed and pressure of washdown pump can be lowered through motor control.

Substitute Equipment & Optional

1. 25 KW DC generator in place of 20 KW.
2. AC generator and motors in place of DC.
3. 250 psi 1½" washdown pump in place of 90 psi.
4. 30 cu. ft. air compressor in place of 17 cu. ft.
5. 61 cu. ft. air compressor in place of 17 cu. ft.
6. 80 gal. air tank in place of 40 gal.

VERTICAL ENGINE DRIVEN PUMPS

Vertical engine driven pumps by Stewart & Stevenson offer the following advantages: The vertical installation saves the cost of a right angle gear drive; it saves the cost of a flexible shaft; it saves the cost of an engine base; it saves the cost of an engine foundation; it saves fuel costs; it reduces maintenance costs by eliminating unnecessary right angle mechanical drives. In addition to savings of up to 20 on initial costs, you actually pump more water due to the elimination of efficiency losses in right angle drive, universal joint and couplings. The new Red-Head package power unit is a self-contained engine driven deep well turbine pump unit. Stewart & Stevenson Services has developed this revolutionary unit using a specially designed, high efficiency Red Head Pump combined with either a diesel, gas, butane or gasoline engine modified for vertical operation with a 25 to 225 hp range.



STEWART & STEVENSON GENERATING SETS

The efficient and compact Stewart & Stevenson Generator Sets are the result of many years of experience gained in the successful application of Diesel generator sets in many different types of applications.

Designing units for the unusual and "tough jobs" has always been a Stewart & Stevenson specialty. A typical example of the versatility of Stewart & Stevenson Generator Sets may be seen in hundreds of Stewart & Stevenson units designed and engineered for operation in climatic conditions varying from —65 degrees F. to +130 degrees F. and at altitudes of from sea level to 10,000 feet, with equal full load efficiency under any of these circumstances.

Some of the more important advantages and features characterizing Stewart & Stevenson Generator Sets are as follows:

1. DEPENDABLE ENGINES—The engines which power Stewart & Stevenson generator sets are supplied in a choice of either General Motors Diesel, Climax natural gas/butane/gasoline, or Chrysler industrial engines.

2. CONSERVATIVE RATINGS—All Stewart & Stevenson generator sets for continuous duty service are capable of being operated at 25% or more overload for intermittent service. These conservative ratings insure long life and dependable service with minor maintenance costs.

3. COMPACT DESIGN. These generator sets are furnished, if desired, in completely self-contained units with all necessary components required for operation in either stationary models, portable skid mounted models, or mobile trailer mounted units. They are noted for their simple yet practical design which permits easy accessibility to working parts for ease of maintenance.

4. HIGH ALTITUDE PERFORMANCE—For continuous duty service they develop full load rated power at up to 10,000 feet elevation.

5. GENERATOR CONTROL PANELS—All switchgear and generator control panels for Stewart & Stevenson generator sets are fabricated and tested for the specific generator unit on which the equipment will be used. This insures high quality output from the completed generator set and eliminates costly adjustments on the job after delivery of the generator set.

Control panels are available in various models to fit the customer's individual application. On portable or mobile units where the unit dimensions are usually held to a minimum, special saddle mounted panels are available.

On units where space permits, larger base mounted models at the exciter end are available.

Free standing floor mount types are available for engine room or large trailer installations.

Wall mounted models are available for engine room or trailer installation

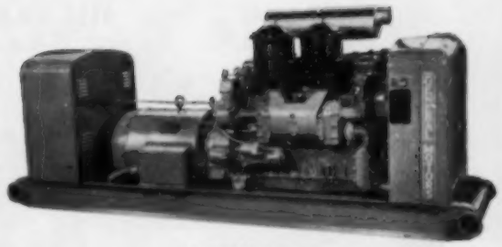
6. AUTOMATIC STARTING AND STOPPING—Where full automatic starting and stopping is desirable, these generator sets can be furnished with completely automatic control systems. Upon failure of the normal source of electrical supply, a unique system of automatic controls starts the emergency engine-generator unit, switches it to the customer's load for the duration of the normal power source failure, and upon the restoration of the normal source, stops the unit and switches the load back to the normal source.

For protection against overheating or low oil pressure on the engine, a set of indicating lights and a special alarm system is provided. These automatic control systems are particularly desirable on emergency standby units for hospitals, radio stations, television stations and other operations where unfailing power is of utmost importance.

7. TESTING—Each generator set is thoroughly tested before delivery. The standard shop test consists of operation of the unit under actual load conditions at ¼, ½, ¾ full load, and overload.

Among the facilities for testing is one of the very few low temperature test chambers capable of testing engine generator sets at a temperature of —80° F.

8. COMPLETE FACILITIES AND FULL RESPONSIBILITY—Stewart & Stevenson Generator Sets are designed, fabricated, and tested all under the same roof including the manufacture of the control panels and switchgear. This complete facility plus the full responsibility for proper design, application, and service by Stewart & Stevenson assures the purchaser of a properly engineered job with assurance of continuity of service and repair.



OPEN TYPE

Where units are housed out of the weather, open type units such as the illustration above are usually furnished. This type is very popular for hospitals, bakeries, cold storage plants, radio stations, etc.

TYPE MB-2

Closed type models such as the type MB-2 illustrated are furnished with a weather resistant enclosure and removable or hinged side panels. These units are usually furnished where a permanent installation is not desirable. They may be operated out of doors without damage by the weather. They are very light in weight yet rugged in design and are winterized for operation at minus 65° F.

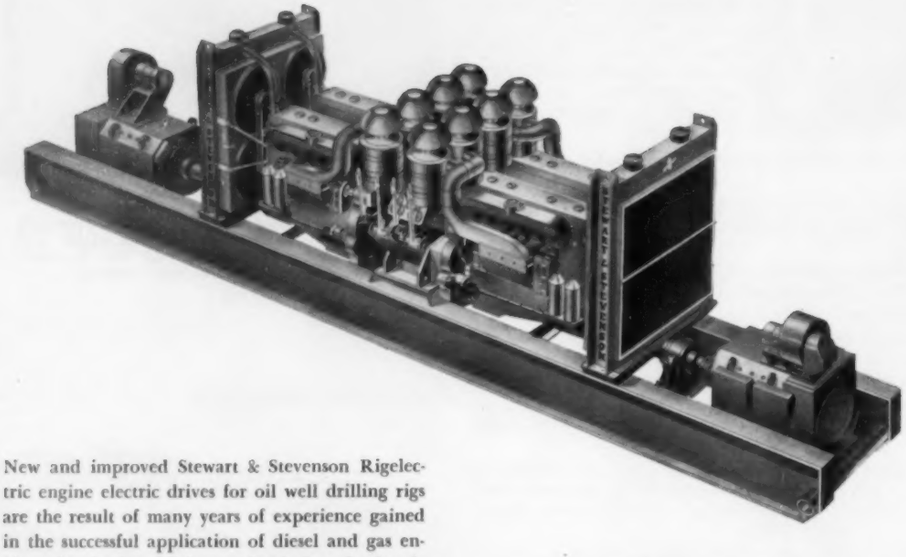
STEWART & STEVENSON AC DIESEL GENERATOR SETS

Model	Capacity	Engine
2GD15C	15KW	GM 2-71
2GD23C	23KW	GM 2-71
2GD35C	35KW	GM 2-71
2GD40S	40KW	GM 2-71
3GD36C	36KW	GM 3-71
3GD53C	53KW	GM 3-71
3GD60S	60KW	GM 3-71
4GD48C	48KW	GM 4-71
4GD70C	70KW	GM 4-71
4GD85S	85KW	GM 4-71
4GD100S	100KW	GM 4-71
6GD72C	72KW	GM 6-71
6GD108C	108KW	GM 6-71
6GD135S	135KW	GM 6-71
6GD150S	150KW	GM 6-71
12GD135C	135KW	GM Twin 6-71
12GD235C	235KW	GM Twin 6-71
12GD265S	265KW	GM Twin 3-71
12GD185C	185KW	GM Twin 3-71
12GD210C	210KW	GM Twin 3-71
110GD110C	110KW	GM 6-110
110GD150C	150KW	GM 6-110
110GD165C	165KW	GM 6-110
110GD190S	190KW	GM 6-110
110GD290C	290KW	GM Twin 6-110
110GD300C	300KW	GM Twin 6-110
110GD330C	300KW	GM Twin 6-110
110GD360S	360KW	GM Twin 6-110
24GD265C	265KW	GM Quad 6-71
24GD350C	350KW	GM Quad 6-71
24GD400C	400KW	GM Quad 6-71
24GD460S	460KW	GM Quad 6-71
24GD500S	500KW	GM Quad 6-71

MOBILE TYPE

Mobile or trailer mounted units are available in all sizes. These units can be furnished for high speed highway trailing or for slower speed trailing where distances between locations are relatively short. These units are extremely compact and completely self contained, ready for instant use. Typical users are public utility companies, carnivals, traveling shows, pipe line builders, etc.

RIGELECTRIC ENGINE ELECTRIC DRIVES



New and improved Stewart & Stevenson Rigelectric engine electric drives for oil well drilling rigs are the result of many years of experience gained in the successful application of diesel and gas engines for both straight mechanical and electric drive in the oil field.

The new and improved Rigelectric arrangements incorporate a simplicity of design associated with the original Rigelectric principles plus a far broader range of improvements and flexibility which provide a variety of "alternates" in the event of an emergency. All of this is accomplished with a minimum use of contractors in the functional operation of the Rigelectric system.

Although Rigelectric arrangements are offered with multiple engine prime movers as standard equipment, Rigelectric can also be furnished with the gas engine of your choice, without sacrificing the full responsibility and guarantee of Stewart & Stevenson Services, Inc.

Unlike other engine electric systems for drilling rig drive, you do not have to suit your rig to some diesel electric manufacturers' standard design. Rigelectric is offered in a complete range of sizes and models to suit your specific requirements. Whether you operate on land or offshore, use diesel fuel or natural gas, prefer trailer mounted, or skid mounting, 3000 foot holes or 25,000 feet, there is a Rigelectric oil field arrangement available which incorporates the following:

1. SIMPLE CONTROLS–With Rigelectric, each electric motor is operated from an individual generator so that there is never more than one motor being driven from a single generator. This arrangement permits the use of a low voltage rheostat control for each generator which in turn governs the speed of each motor. Rigelectric controls contain fewer parts, are ruggedly built for oil field service, and consequently are easier to service.

2. MULTIPLE ENGINE DEPENDABILITY–On the Model 24-1000 Rigelectric power packages, four 250 hp engines with a combined capacity of 1000 hp are furnished. With this arrangement, if one engine should be out of service, then the other three combine to give ¾ of the full power into the generators.

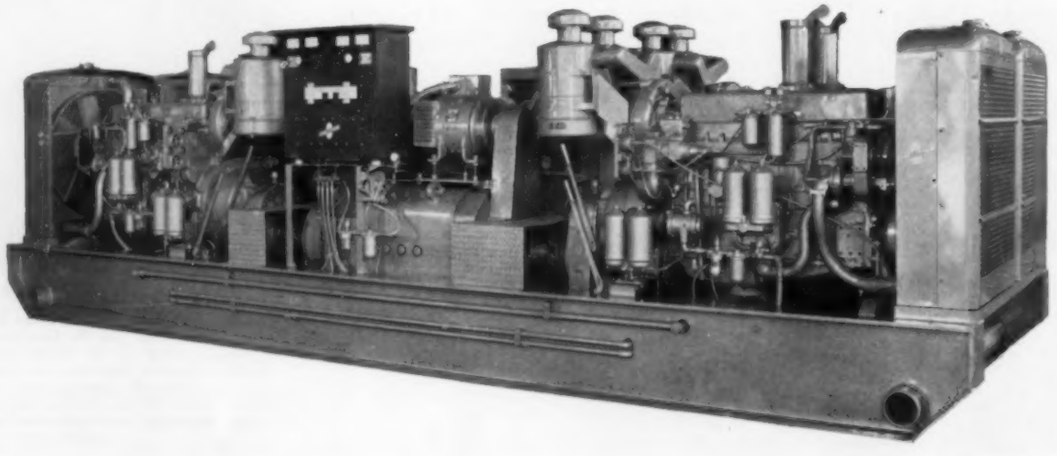
3. CONSERVATIVELY RATED ENGINES–The engines offered with Rigelectric are designed and proven in oil field service and produce their horsepower with lower BMEP, low piston speeds, and have adequate reserve for over loading on intermittent service. For example the Model 24-1000 Rigelectric power package develops 920 continuous horsepower with a BMEP of only 76.5 psi. This is far lower than any other competitive power package offered for diesel electric drive. At a BM EP of 85 psi (which is still far lower than competitive diesel electric power packages) the Model 24-1000 Rigelectric unit develops over 1000 bhp. These conservative horsepower ratings insure longer life with trouble-free service.

4. SHUNT WOUND MOTORS–Rigelectric systems employ the use of shunt wound motors which operate in parallel with each connected generator. Shunt motors have as an inherent characteristic a definite design top speed. No torque limit or overspeed controls are necessary with shunt motors consequently simplifying controls and adding to the safety and simplicity of the entire system.

5. LOWER VOLTAGE–Rigelectric systems operate at only approximately one half of the line voltage as some other diesel electric systems. This results in greater safety as well as less maintenance especially on offshore installation.

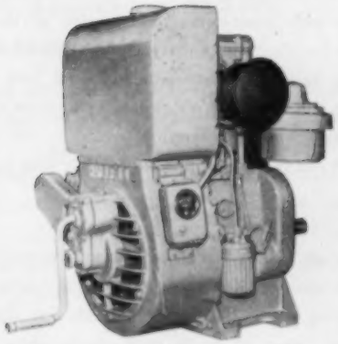
6. PARTS AND SERVICE–Rigelectric units use only standard electrical components which are available from Stewart & Stevenson stocks. The normal inventory of back up parts consists of every single component, either electrical or mechanical, that goes into a Rigelectric arrangement.

7. ONE RESPONSIBILITY–Rigelectric units are designed, built, tested and backed by Stewart & Stevenson Services, Inc. one of the world's largest distributors of diesel engines. The responsibility of Stewart & Stevenson Services, Inc. and the attitude of the management of Stewart & Stevenson toward "after sales service" and customer satisfaction is thoroughly tested, tried and proven in oil field circles everywhere. Regardless of what type engine you choose to power your Rigelectric system, Stewart & Stevenson guarantees the successful performance of the complete equipment on your job.

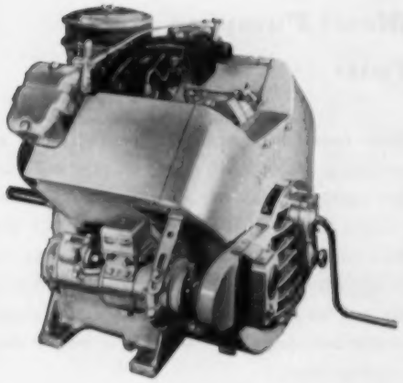


AMERICAN MARC

MODEL AC1: Air-cooled, single-cylinder, compact 5.5 - 6.5 bhp diesel engine.



MODEL WC1: Water-cooled, one-cylinder 6-7 bhp.



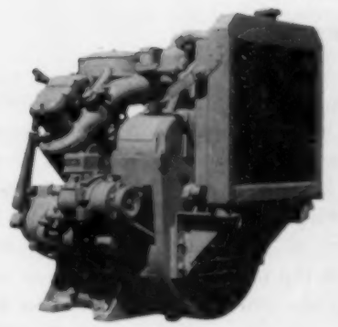
MODEL AC2: Two-cylinder, air-cooled, 13-14 bhp.

LAST year the Diesel Division of the Hallett Manufacturing Company was purchased by American MARC Inc. The entire operation of this division has been streamlined and modernized by the introduction of new engineering and mass-production techniques, making American MARC's leading position in the small Diesel field a stronger one than ever before in both foreign and domestic markets. First in a large number of projected improvements in the line is the increased horsepower (5.5 to 6.5) offered in the American MARC model AC1 air-cooled engine, through camshaft and blower-housing modifications.

The AC1 is an important member of American MARC's "Big 4"—four basic small medium-speed Diesels that answer every purpose within their horsepower range and supply the desired "lugging power" for reliable day-in and day-out operation. The AC1, for example, with dimensions of 27.4" x 19.5" x 24", has been adapted to hundreds of uses from generating plants to main propulsion for ore cars in trackless mining operations.

American MARC'S "Big 4"

In addition to the air-cooled AC1, the Big 4 includes a water-cooled equivalent, the 6-7 bhp WC1; the two-cylinder 13-14 bhp air-cooled AC2, and the 14-15 bhp water-cooled WC2. American MARC also adapts these to marine models; and for heavier marine propulsion work, manufactures the "D" series—vertical one- and two-cylinder Diesels ranging up to 20 bhp.



MODEL WC2: Two-cylinder, water-cooled, 14-15 bhp.

American MARC Diesel Generator Plants

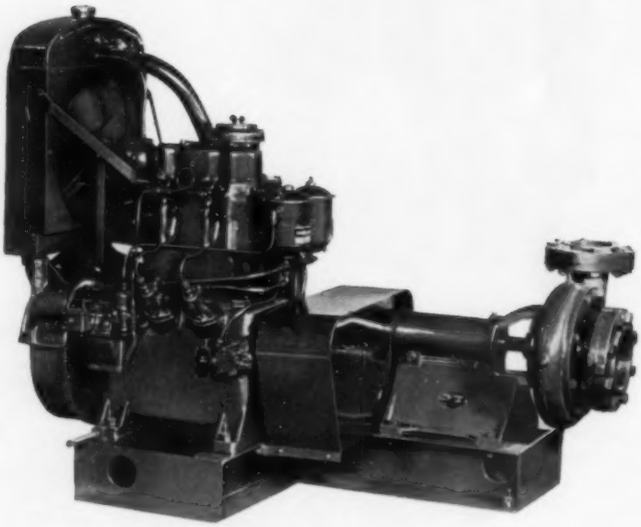
Perhaps the most popular application of the basic American MARC Diesels, both air- and water-cooled, is for electric generating plants from 3 kw to 10 kw capacity. American MARC assembles these plants, both ac and dc, and sells them as complete units with generators quill-mounted to the engines. Standard equipment includes vibration dampening base, generator-mounted panel with voltmeter, fuse, and circuit switch, and power outlet terminals. Battery-charging plants include wall panel and ten feet of flexible conduit wire and fittings.

Both air- and water-cooled plants are available for dc lighting plants, 32-40 and 110-125v; dc battery charging plants, 32-40 and 110-125v; ac lighting plants, either 50 or 60 cycle, single phase 115v or 115/230v; three-phase industrial plants 120/208v.

MODEL A1Q: 3KW generator quill-mounted to American MARC air-cooled model AC1. This and 5kw A2-Q generator ideal for small boat, home or farm.

American MARC Diesel Pumping Units

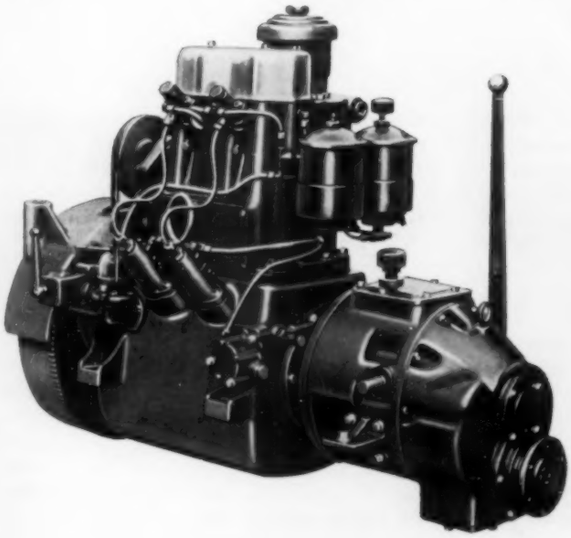
These consist of complete engine and pump assemblies available in varying gpm, pipe and head sizes consistent with the American MARC horsepower range. Outfits powered by the AC1 and WC1 engines are rated from 48 to 450 gpm, the D1 series from 150 to 1000 gpm, the D2 series from 360 to 1700 gpm. Pumps are ball-bearing single-suction centrifugal type, with either belt or flex-coupling drive.



MODEL D2-1700: Centrifugal pump powered by D2 engine; 1700 gpm with 30' head. Discharge size 3", inlet size 4". Weight 810 lbs.

American MARC Marine Diesels

All American MARC Diesels may be converted to "M" or marine models by the addition of a marine-type crankcase and other changes. Thus the AC2 becomes the AC2-M, the WC2 the WC2-M, etc. For marine propulsion units, the 13-14 bhp AC2-M, 14-15 bhp WC2-M, the 8 bhp D1-M, and the 18 bhp D2-M (D2-M pictured below on this page) have proved the most popular. For driving compressors, pumps, or generators, the AC1 and WC1 are ideal units.



MODEL D2-MSR: Water-cooled marine diesel, 2-cylinder, four-cycle, valve-in-head; 18 bhp at 1500 rpm. Reverse and reduction gears optional.

General Information

American MARC Diesels are value-in-head, four-cycle engines employing a high-pressure, solid-injection fuel system with individual injectors and injector pumps operated from engine camshaft. Recommended fuel is any clean automotive or heavy Diesel oil 28 to 45 A.P.I., cetane number 36 or better. Other fuels may be used satisfactorily, such as kerosene, Chevro-Jet, and JP-4 jet fuel. Lubrication is by pressure feed to all bearings at 50 psi.

Standard equipment includes fuel oil filter with 5-micron full-flow replaceable element, air cleaner, and fuel transfer pump. Available attachments: 12v electric starter with or without battery-charging generator; chain, lever, or hand-operated open belt utility clutch; enclosed clutch; reverse gear; 2:1, 2.5:1, or 3:1 reduction gear; radiator-fan or dual-pump heat exchanger cooling system; cold-weather glow plug and air intake heater; remote control and shutdown devices; flexible exhaust extension, tachometer.

All engines are designed on the built-up basis, starting assembly from crankcase up. This permits maintenance and repair with minimum expense and without removing the engine from its operating position. The simplicity of stocking parts for the entire line of American MARC engines is considered one of the most important advances in lightweight Diesel design. There is a maximum inter-changeability of parts in the American MARC diesel family, including most normal replacement or service parts.

In the AC and WC series, cylinders and heads are cast in one piece, thus eliminating the possibility of leaky head gaskets and permitting the use of a high-grade, close-grain, sorbo-cast molydbenum alloy iron which precludes the need of cylinder liners. Crankshafts in all models are drop-forged from high-alloy molybdenum steel, hardened and heat-treated throughout. Extra large connecting-rod journals reduce unit loads well within limits to assure long and satisfactory bearing life. Pistons are permanent-mold, cast alloy aluminum, heat treated and age hardened. Four compression rings above the pin and an oil scraper at the bottom of the skirt insure freedom from blow-by and wasteful oil consumption. Camshafts are special steel, and cams are integral with shaft. Camshaft bearings are bronze bushings in crankcase.

The American MARC Warranty

Behind each American MARC Diesel engine stands the American MARC warranty, which guarantees every unit within the limits of its horsepower and capabilities. A further guarantee is the fact that American MARC today is the country's largest manufacturer of air-cooled Diesel engines, maintaining this leadership in the face of mounting domestic and foreign competition.

AMERICAN MARC DIESEL SPECIFICATIONS

Engine	BHP @ 1800 RPM	Cylinders	Piston Displacement Cu. in.	Bore	Stroke	Compression Ratio	Cooling	Starting[1]	Power Takeoff	Length	Width	Height	Weight lbs.	Misc.
AC-1 air-cooled	5.5-6.5	one, vert.	34.8	3½"	3⅝"	20 to 1	flywheel blower	1:2 handcrank	4⅞" shaft stub 1⅜" dia.	27.438"	19.5"	24"	220	enclosed flywheel
AC-2 air-cooled	13-14	two, v-type	72.157	3½"	3¾"	20 to 1	flywheel blower	1:2 handcrank	7" shaft stub 1¾" dia.	33.594"	25.62"	28.18"	350	enclosed flywheel
WC-1 water-cooled	6-7	one, vert.	34.8	3½"	3⅝"	20 to 1	for tank[4] or off engine system	1:2 handcrank	4⅞" shaft stub 1⅜" dia.	27.438"	17.75"	25.375"	220	enclosed flywheel
WC-2 water-cooled	14-15	two, v-type	72.157	3½"	3¾"	20 to 1	water[5] circ. pump only	1:2 handcrank	7" shaft stub 1¾" dia.	33.594"	25.62"	27.12"	350	enclosed flywheel
D-1A water-cooled	8 @ 1500	one, vert.	50	3⅞"	4¼"	20 to 1	for tank[4] or off engine system	1:1 handcrank	4-5/16" shaft stub 1⅜" dia.	24.07"	24"	39-15/16"[2]	582	D-1, D-2, full-flow lube oil filter
D-2 water-cooled	18 @ 1500	two, vert.	100	3⅞"	4¼"	20 to 1	water[5] circ. pump only	12v electric	7" shaft stub 1¾" dia.	35.9"[3]	23.0"	29.78"	810	D2, flywheel guard

1. 12V automotive-type electrical starter and battery generator optional. 2. With radiator; 36" without radiator. 3. With reverse gear. 4. Tank and fittings not furnished. Thermosyphon radiator and fan optional. 5. Optional: radiator and fan complete (pump circulated).

GENERAL MOTORS

ELECTRO-MOTIVE DIVISION

THE General Motors Model 567C Diesel and Model 567CDF dual-fuel engines are manufactured by the Electro-Motive Division. The diesel engine has been used principally in railroad service. With minor modification the engines are used for mobile power units and stationary service. Marine applications are handled by the Cleveland Diesel Engine Division of General Motors.

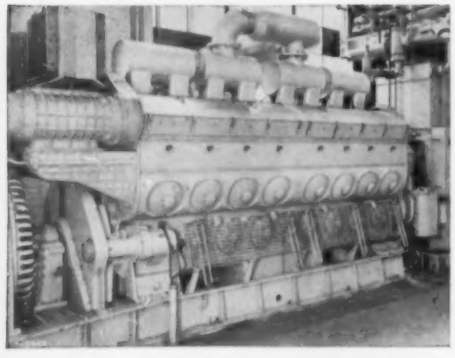
Model 567C Diesels have cylinders 8½ by 10 inches, are built with eight, twelve and sixteen cylinders, and develop from 900 to 1750 horsepower at 800 to 835 rpm and power generating units from 500 to 1000 kilowatt capacities at 720 rpm. All engines are of V-type with 45 degree angle between cylinder banks. All operate on the two-cycle principle with uniflow scavenging. Special consideration has been given to design features which will facilitate maintenance operations and simplify spare parts supply. To this end, all engines use the same cylinder head, piston, connecting rod and bearings, as well as external accessories. The relatively small size of pistons, heads, and liners makes use of a crane necessary only when completely disassembling the engine. The general construction of these engines and many of the details are shown in the sectional view given here.

UNIFLOW SCAVENGING is accomplished by admitting scavenging air through the piston controlled ports in the lower cylinder wall and discharging the exhaust gases through four poppet valves in the cylinder head. Scavenging air is supplied by positive displacement helical three-lobed Roots type blowers, mounted at the upper flywheel end of the engine.

OIL PAN is a welded fabrication of steel plate. It provides a mounting for the engine, acts as an oil sump, and together with the crankcase forms a rigid self-supporting engine structure. Openings are provided on both sides to give easy access to the crankshaft space and the bearings.

CRANKCASE is fabricated of rolled sections, steel plates and forgings welded together. Cylinder heads are held in retainers by crabs and studs which transfer firing load through the rolled sections to the main stress members supporting the crankshaft and main bearings. This provides straight line transfer of gas loads from the cylinder heads to the main bearings. A large scavenging air reservoir is formed by the walls of the crankcase, and liberal sized openings along the sides give access for maintenance purposes. Replaceable wear inserts are provided at the lower liner pilots.

General Motors Model 16-567C, 2-cycle Diesel stationary installation.



CYLINDER LINERS are double-walled iron castings incorporating the cooling water jackets. Air inlet port struts are full water cooled. The liner is supported from the cylinder head by studs and does not carry tensile nor compressive operating loads.

CRANKSHAFT is drop forged of special carbon steel with induction hardened main and crankpin journals. The 7½ inch main journals and the 6½ inch crankpins result in conservative loadings and long bearing life. Crankshafts are dynamically balanced and are fitted with torsional vibration dampers where necessary to keep stresses to a minimum. Oil passages in the crankshaft provide a continuous supply of oil to the connecting rod bearings.

MAIN BEARINGS are steel shells, of ample thickness to avoid distortion, lined with lead-bronze alloy with lead-tin overlay. They are of precision type and fitted without shims or scraping. Caps are steel forgings and held in place by heavy studs.

CONNECTING RODS are of steel, drop forged with I-section shanks, and carefully blended to avoid stress concentrations. The fork-and-blade construction eliminates cylinder offset and improves connecting rod bearing load conditions. Two-cycle operation eliminates load reversal and makes possible a fork rod cap design which allows the connecting rod to be removed through the cylinder in spite of the large crankpin diameter. The crankpin bearing extends the full width of the crankpin and is steel backed, lead-bronze lined with lead-tin overlay. Outer surface of the shell is coated with lead-bronze to form a bearing for the slipper blade rod. Shells are of precision type and are fitted without shims or scraping. Upper ends of the rods are fitted with a trunnion type steel, hollow bored piston pin silver plated and bolted to the rod.

PISTONS are oil-cooled floating type, which allows the outer surface of the piston to rotate in the cylinder, distributing piston skirt wear, reducing liner wear, and improving ring performance. The uniform section of the iron piston reduces thermal distortion and permits closer fitting of the rings and skirt, as well as permitting removal of connecting rod and piston pin carrier through the oil pan access openings. The trunnion type piston pin carrier is a steel forging case hardened with a highly polished bearing surface for the silver plated piston pin.

CYLINDER HEADS are individual special iron castings, water cooled, with the unit-type fuel injector in the center, with the four exhaust valves around the injector. The four valves of heat-resisting steel are operated from overhead camshafts by forged steel rocker arms with roller followers. Hydraulic lash adjusters and forced lubrication in all moving parts reduce maintenance of valve gear to a minimum.

CAMSHAFTS are mounted overhead and made in sections of carbon steel forgings joined by dowelled flanges, and sectional replacements may be made. Camshaft journals and cam profiles are induction hardened. Counterweights mounted on both ends are provided for primary balancing. A gear train at the flywheel end of the engine drives the camshafts and scavenge air blowers.

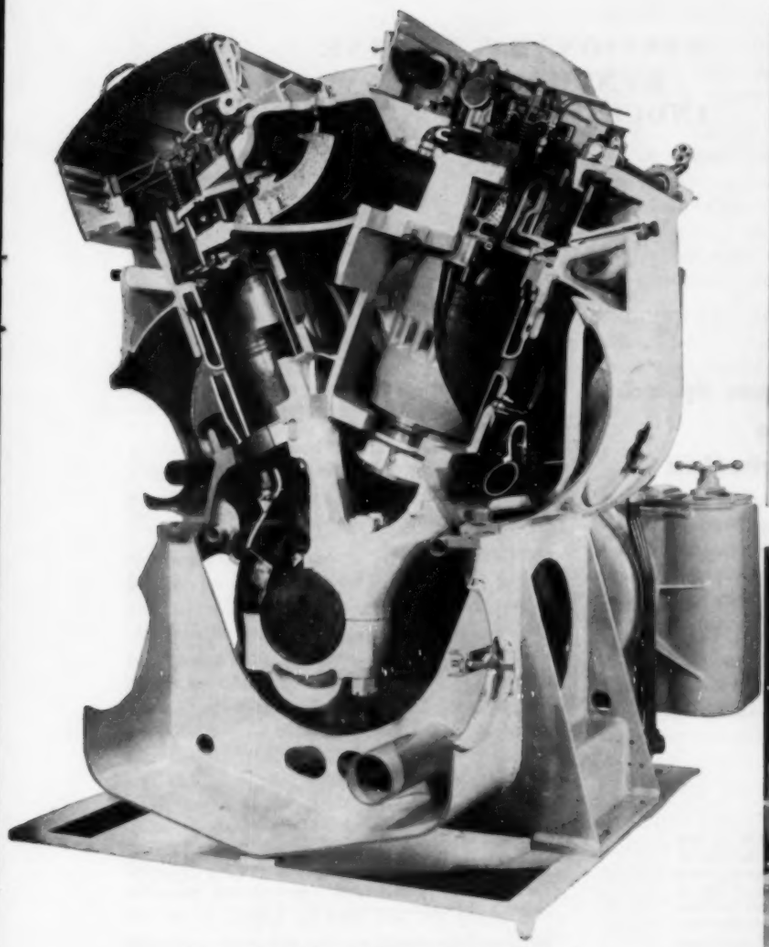
FUEL INJECTION is by the General Motors type of unit injector. Injection pump and nozzle are combined in one unit. The pump is actuated directly from the camshaft by a forged steel rocker arm. Low pressure fuel is supplied by an electric motor driven or engine driven fuel supply pump. High pressure fuel is confined to a short length of passage at the lower end of the injection unit. Engine speed control is by hydraulic governor which acts through a layshaft to the injector control racks which determine the quantity of fuel injected.

GOVERNORS are available in a wide variety of types for various applications and are driven from the accessory gear train. Overspeed protection is afforded by an independent trip mechanism actuated by a flyweight on the camshaft. Pawls actuated by individual springs, latch the injector rocker arms, stop fuel injection when overspeed occurs.

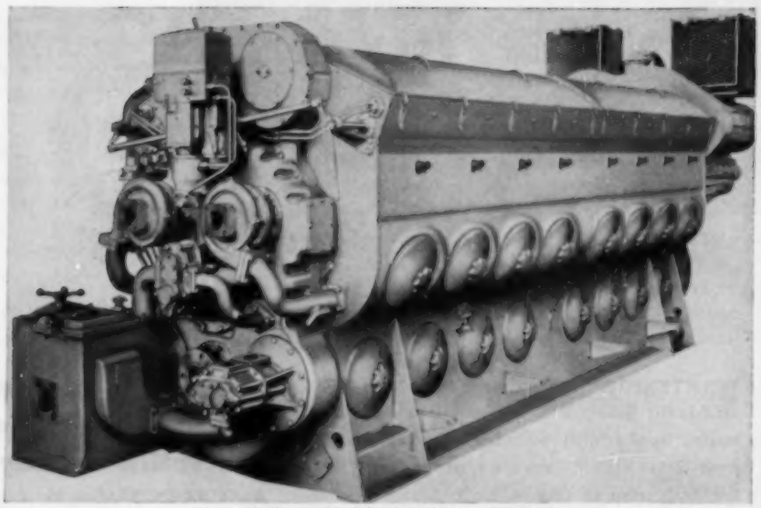
LUBRICATING AND PISTON COOLING OIL is supplied by a two-section helical-gear pump of capacity sufficient to insure adequate cooling and lubrication under the most adverse temperature conditions. A herringbone scavenge pump draws oil from the engine sump and forces it through external filters and coolers and back to the engine oil strainer housing. Strainers of generous capacity for main and scavenge pumps are provided as an integral part of the engine. Strainer housing also provides an oil filler opening.

COOLING WATER pumps of centrifugal type are identical for all engines with one being used on six and eight cylinder engines, and two on twelve and sixteen cylinder engines. Water jumpers are used at the lower end of the cylinder liner and upper end of the cylinder head. The lower jumpers are bolted to removable water inlet manifolds on both sides located within the air box portion of the crankcase. The upper jumper is bolted to the cylinder head, serves as a locating device for the cylinder head, and permits the discharge of water into the upper manifold which surrounds the exhaust elbows and is integral within the crankcase.

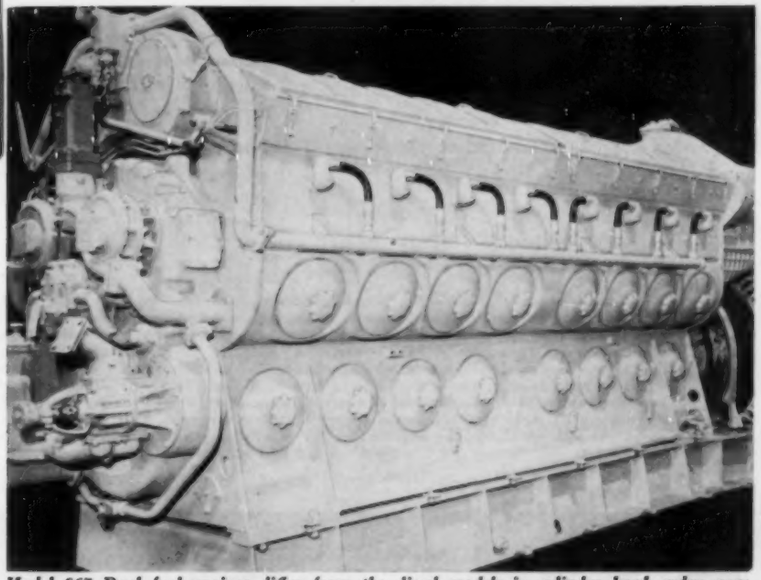
ENGINE ACCESSORIES, including all pumps and governor, are located on the front end of the engine and are driven through a torsionally flexible drive gear.



Cross section of General Motors 567-C series, 2-cycle V-type Diesel engine.

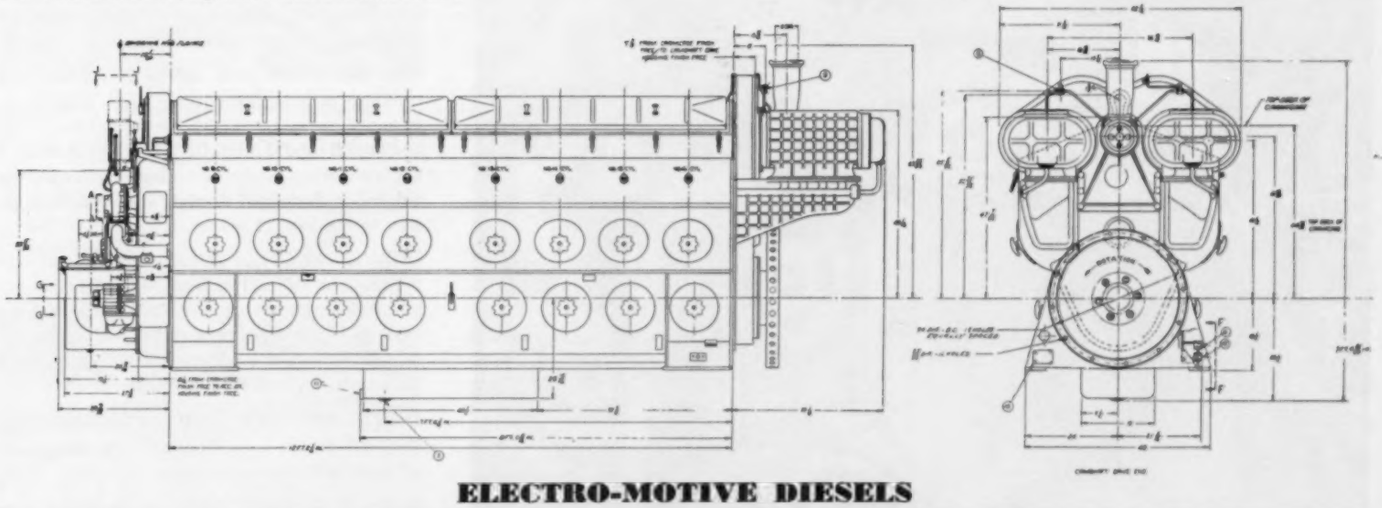


General Motors Model 16-567C, 2-cycle Diesel.



Model 567 Dual fuel engines differ from the diesel models in cylinder head, valve gear, injectors, and require gas valve and piping.

Below: Installation drawing Electro-Motive 16-567C Diesel.



ELECTRO-MOTIVE DIESELS

Model	Cycle	H.P.	Cyls.	Bore	Stroke	RPM.	Comp. Ratio	Stationary	Railroad	Displacement	Weight	Power Plant
8-567C	2	900	8	8½	10	835	16-1	Yes	Yes	4540	18,000	500KW at 720 rpm.
12-567C	2	1200	12	8½	10	800	16-1	Yes	Yes	6810	25,000	750KW at 720 rpm.
16-567C	2	1750	16	8½	10	835	16-1	Yes	Yes	9080	31,500	1000KW at 720 rpm.

ENTERPRISE

STATIONARY, MARINE GENERATOR SETS INDUSTRIAL, PUMPING

ENTERPRISE engines range from 73 to 7703 brake horsepower, for both stationary and marine applications. Stationary generator units from 47 to 5502 kilowatts are available. There are five basic models, four inline engines and one V-block engine. All models operate in the slow or medium speed ranges.

In addition, all Enterprise engines are available for use with various fuels, including diesel, dual fuel, gas, tri-fuel, heavy or residual fuels or spark ignited. All models may be turbocharged or may be operated normally aspirated.

Slow and Medium Speed Engines Inline Construction

CAST IRON BASE is of one piece construction and supports the crankshaft and bearings. In stationary applications the mounting flanges form the lowest surface in order to simplify installation. Marine engines are equipped with drop center bases, with an aft extension for thrust bearing and barring device support.

FORGED STEEL CRANKSHAFT is machined on all surfaces from a steel forging and is rifle drilled to provide pressure lubrication of the crank pin bearings.

MAIN BEARINGS are of the removable precision shell type. Front and rear bearings are of extra length to reduce unit pressure. Lower shells are replaceable without disturbing crankshaft.

CYLINDER BLOCK is machined from a single casting for the entire engine, and is of uniform section, heavily ribbed and designed to provide uniform cylinder cooling. Through bolt construction is used to absorb working pressures and to relieve tensile stresses in the block. Air manifolds are cast in the block. In Model G engines the water manifold is also cast. Camshaft bearing supports are integral in the block. Camshaft tappets and push rods are enclosed within the block, and access may be gained through large, lightweight access doors.

CYLINDER LINERS of the wet type are cast from special alloy iron. Water jackets are provided throughout the full working length. Liners are fitted metal-to-metal at the top with expansion joints provided at the bottom, sealed with double rubber rings with an external leak-off opening between rings.

CONNECTING RODS are fully machined from steel forgings and are balanced to insure identical weight. Rods are bored throughout their length in order to reduce weight and to provide oil passages to the wrist pins which are carried in bronze bushings. Removable precision type bearing shells are fitted in the cast steel connecting rod bearing boxes.

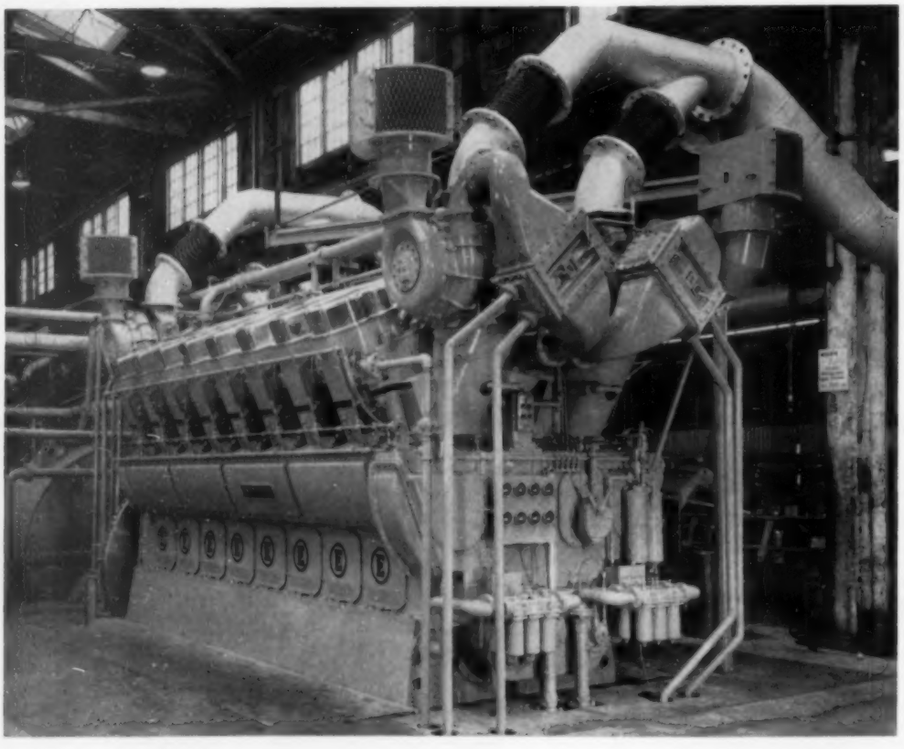
PISTONS are oil cooled and are of the full skirt type incorporating full floating piston pins. Enterprise pistons are fitted with five compression rings and two oil control rings. Oil for cooling is directed under the crown of the piston from the connecting rod and is discharged through a short tube to return to the base of gravity.

INDIVIDUAL CYLINDER HEADS are fitted with the necessary valves. Heads are of special alloy cast iron with ample water passages to provide uniform cooling. Lightweight, removable head covers enclose the valve gear mechanism. Valve guides are of high-grade cast iron to insure long life.

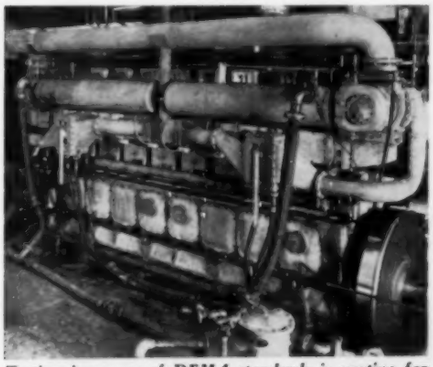
INLET EXHAUST AND STARTING AIR VALVES are of large diameter and operate on pressure lubricated rocker arms.

CAMS AND CAMSHAFTS are machined from high nickel steel forgings, and surfaces are ground to close tolerances. Camshaft drive is by means of helical gears, machined from steel castings and forgings.

The Enterprise model DSRV-16-3 sixteen cylinder turbocharged engine, rated 7700 HP @ 400 RPM, showing fuel and lube oil filter arrangement, intercooling equipment. Note the use of four turbochargers with individual filter silencers, standard equipment for this compact power plant. Over-all, the engine is 26′ 4″ long, 9′ 4″ wide, 12′ 1″ high. Its relatively small size is due to new design developments, which enhance the V-design's inherent advantages in four ways: 1) provide *minimum* over-all engine length; 2) hold bearing loadings to extremely conservative values; 3) permit removal of con rods without removing cylinder liner, with *minimum* down-time; 4) make possible interchangeability of many parts with other Enterprise engine series. As with all Enterprise engines, the RV is available with diesel, dual fuel, tri-fuel and spark ignited fuel systems.



The "Mokuhana," owned by Bay and River Navigation Co., San Francisco, hauls maximum loads of 575 tons of sugar. Two Enterprise DMM-36, turbocharged, 6 cylinder engines drive her at average speed of 10.8 knots.



Testing in excess of DEMA standards is routine for every engine leaving the Enterprise Engine plant. This engine is one of two for New Smyrna Beach, Florida, municipal electric plant to operate on heavy fuel. An Enterprise DSR-38 rated 2532 HP at 360 RPM developing 1800 K.W., this engine is shown being tested complete with attached heavy fuel accessories.

At Glades Electric Cooperative, Moore Haven, Florida two Enterprise Model DSQ-36 Diesels, each rated 1200 HP at 327 RPM, were installed in 1948, followed by third in 1952. Economical operation has reflected in reduced KW cost.

Two Enterprise DMG-8 diesels deliver 450 HP at 325 RPM, giving the 117 foot "J. W. Bedford" plenty of power and maneuverability for her toughest river tows. The boat, owned by the Bedford-Nugent Co., Inc., operates on the Ohio River out of Evansville, Indiana.

VALVE ACTUATION is provided by pressure lubricated, cast steel rocker arms and steel tubing pushrods. Rocker arm groups, individual for each cylinder, are supported by the cylinder heads.

HYDRAULIC TYPE GOVERNORS are standard for all stationary and most marine applications and provide regulation within 3% from no load to full load and within 1% for normal load changes. Marine engines are also provided with Enterprise single lever controls which allow speed, engine direction and starting from one control.

INDIVIDUAL FUEL INJECTION PUMPS, are driven directly from cams on the camshaft and discharge to centrally located spray valves through high pressure tubing.

V-Block Slow Speed Engines

Enterprise Model RV engines 17x21 bore and stroke are available in 12 and 16 cylinders. A special feature of these engines is the simplified maintenance resulting from the unique connecting rod design. (See the cross-section drawings on pp. 164 and 167.)

CAST IRON BASE is of one piece construction. The base is wide in proportion to its length and provides main bearing and crankshaft support. Wide, precision machined mounting flanges form the lowest portion of the engine and provide large load bearing area.

HEAVILY RIBBED CAST IRON CRANKCASE supports the gear driven cam shafts and the cylinder blocks. Large through bolts are used to secure the base, crankcase and blocks into a single operating unit. Camshaft bearing supports are precision bored to rigid standards.

CRANKSHAFTS are machined on all surfaces. The large diameter journals and crank pins have a "reentrant fillet" design which provides bearing areas of the greatest size and with smallest loadings.

BEARINGS are the removable precision type with tin babbitt linings for both the main and connecting rod bearings. Grooving has been eliminated on the lower half of the main bearing shell and on the upper half of the connecting rod shell. This reduces oil film loads and increases bearing capacity with the added benefits of increased durability and reduced bearing wear. This grooving, in conjuction with special crankshaft drilling, assures greater than normal flow of oil for wrist pin lubrication and piston cooling.

CYLINDER BLOCKS are separate for each bank of cylinders and are designed with maximum water cooling passages.

WET TYPE CYLINDER LINERS, are fitted metal-to-metal at the top and with an expansion joint at the bottom.

CONNECTING RODS, MASTER AND LINK, are precision machined from steel forgings of the highest quality. Unique design allows the rod and piston assembly to be removed from the engine without disturbing the cylinder liner.

Oil cooled cast iron pistons are fitted, as are individual cylinder heads and fuel injection pumps. Valve gear is similar to that used in the in-line series.

MANIFOLDS for air, exhaust and water are of welded construction and are easily removable for maintenance.

Medium Speed Engines Inline Construction

M Model 8x10 bore and stroke are a compact, medium-speed engines available in 3, 4, 6 and 8 cylinders, turbocharged or normally aspirated. These engines are of the wet sump type; with slung crankshafts supported by bearings in the block. Wet type cylinder liners are used. Standard cylinder heads span 2 cylinders (except on the 3 cylinder model), and external air exhaust and water manifolds are provided.

General Features All Engines

LUBRICATION of all Enterprise engines is by full pressure system, with all wearing parts continuously fed or bathed in lubricant. Due to the generous design of main and crankpin journals, oil consumption is extremely low. The main pressure pump is engine mounted and is driven from the crankshaft except in V-block engines. Double pressure scavenger pumps are used on slow speed marine models.

COOLING systems are of standard design with engine mounted water pumps as required, except with V engines.

TURBOCHARGING is available for all engines. Both Elliott or Brown-Boveri turbochargers are used. On medium speed M engines, turbochargers are available at flywheel end only. All other engines may be turbocharged at either end.

INTAKE AIR TEMPERING equipment is available for all engines permitting greater outputs at elevated ambient temperatures. Space requirements for tempering equipment has been minimized by careful design.

DIRECT REVERSING is standard in G, Q, R and RV Models and is accomplished by shifting the camshaft. A single lever controls all phases of engine operation including starting, direction of engine rotation and speed. A unique cam system allows multi-station control with automatic adjustment between stations.

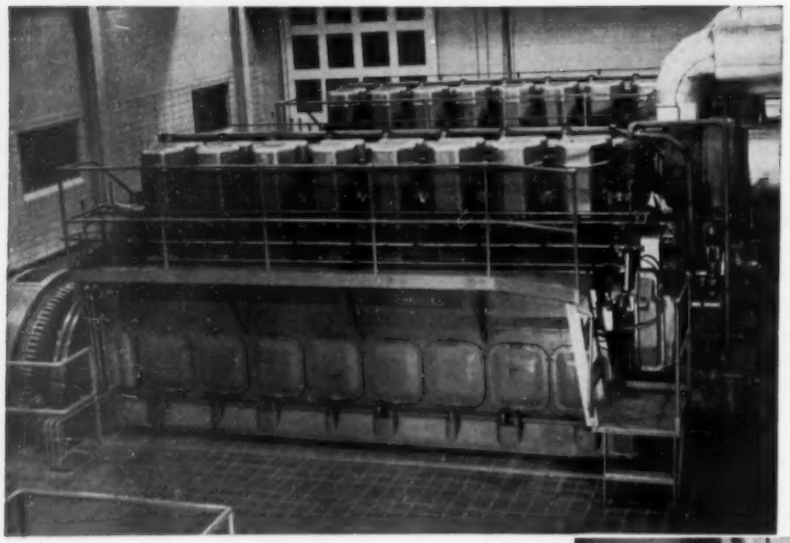
Fuels

All Enterprise engines are capable of burning efficiently fuels ranging from #2 diesel oil through the low grades of residual oils. Engines burning Bunker C fuel have been in operation for over 10 years.

Spark ignition engines incorporate dual magneto systems of the low tension type. Dual spark plugs and high tension coils assure complete ignition of the gaseous charge. Control of starting, choking and operation of spark ignition engines is embodied in a single operating switch.

Enterprise dual fuel engines are equipped with a single control lever for instantly changing fuel combinations. Automatic changeover, in any proportion, is available without the possibility of dangerous overloading.

Tri-Fuel Enterprise engines are completely equipped to burn oil, oil-gas or straight gas fuels by effectively combining the features of the dual fuel and spark ignition engines.



NEW ELECTRIC GOVERNOR AT TIPP CITY, OHIO

On an Enterprise DGSG-36 Engine at the Tipp City, Ohio, Municipal plant, the new Westinghouse electric governor is proving the fastest yet. Electric load sensing anticipates load change. Frequency deviation and response speed are cut in half. Frequency swing caused by 400 KW transients has been cut down from 2—3 cycles to less than ⅓ cycle.

DUAL FUEL

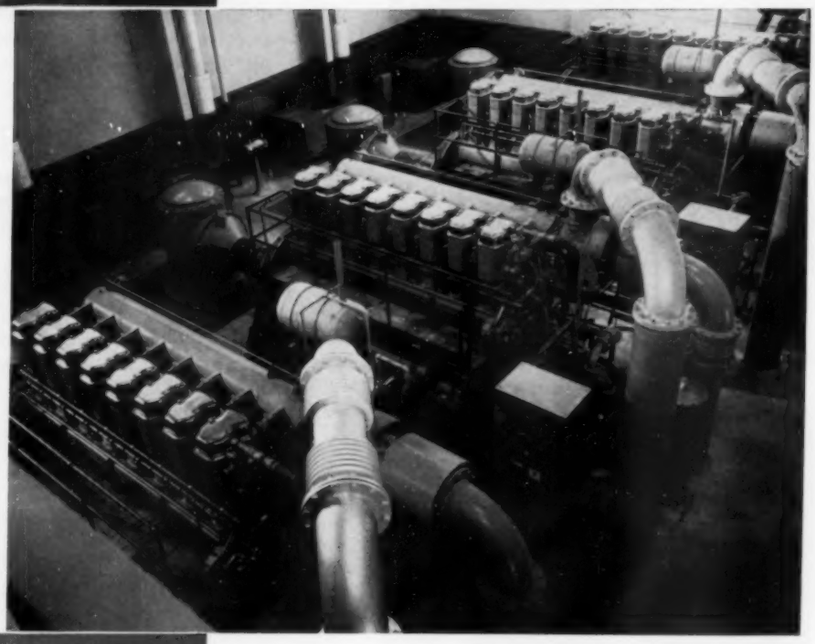
Enterprise engines come fully equipped for operations using fuel oil in combination with natural, sewage, or manufactured gas. At Tipp City, each of the two Enterprise DGSQ-318 engines develops 1240 KW using heavy oil and gas available locally. Low oil-gas combinations down to 5% oil-95% gas are possible using Enterprise dual fuel stationary engines.

OAKLAND, CALIFORNIA STORM WATER PUMPING STATION

Four Enterprise DSG-318 diesel engines power the $4,600,000 Oakland Storm Water Pumping Station. Exact pumping requirements for control of flood waters are met by the flexibility of the over-all Enterprise control systems, and all of them completely automatic.

650 million gallons of storm water can be pumped through this Enterprise equipped station in 24-hours —a full railroad tank car every second!

Your flood problem can be prevented by calling in qualified Enterprise engineers now to assist you in planning adequate, independently powered flood control facilities. No matter what pumping capacities you require, there's an Enterprise Engine designed to do the job more efficiently and at lower cost.



NEW YORK'S NEWEST FIREBOAT, THE "JOHN D. McKEAN"

New York's newest fireboat, the 130 foot "John D. McKean," packs more diesel power than any fireboat ever built. Its huge pumps, independently driven by two of the four Enterprise one-thousand horsepower diesel engines, are capable of throwing in excess of 14,000 gallons of water out a minute . . . at 150 pounds nozzle pressure!

The other two Enterprise Diesels provide a completely separate source of power for propulsion . . . insuring quick-acting maneuverability at all times.

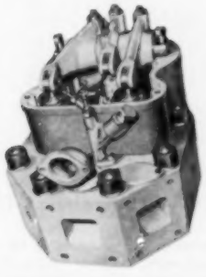
More and more, Enterprise Diesels are the choice of power experts for sustained dependability and performance. For every heavy-duty marine and stationary application, specify Enterprise Units to 2700 hp.

PRECISION BEARINGS

All main and connecting rod bearings are of the bronze-backed precision type with high alloy facing. Camshaft bearings are also of the precision type. All bearings are pressure lubricated throughout. Large crankshaft and connecting rod bearing diameters reduce stresses and decrease unit bearing loads. Simplicity of design plus accessibility through large hand-hole plates permits easy removal of main bearings for inspection and replacement.

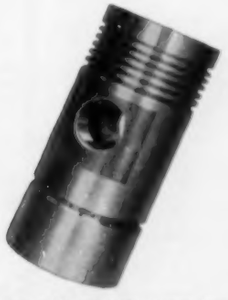
CAMSHAFTS

Cams are forged from high quality steel and ground to close tolerances. Camshafts are of ample size to assure the necessary strength and rigidity demanded. The exhaust and intake cams are forged of high alloy steel, carburized and surface finished by an exclusive Enterprise process which results in long life.



HEAD & ROCKER ARM ASSEMBLY

The special alloy iron head contains large water passages to assure uniform rapid circulation and maintain minimum valve temperature. Large area valves, located directly in head, are designed for even flow and minimum restriction. By merely removing the oil and dust-proof cover, easy accessibility is provided to the fuel nozzles, and to the pressure lubricated rocker arms. Three rocker arms are used in each cylinder head to operate the air starting, exhaust, and air intake valves.



HEAVY DUTY PISTONS

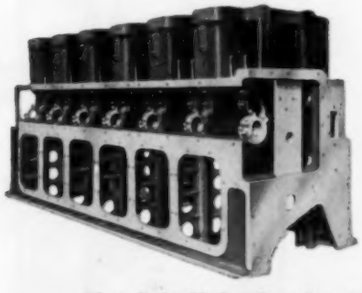
Pistons are of uniform design of quality-controlled cast iron. Oil cooled pistons are supplied on all models with special controlled flow cooling passages. Pistons are of stiff ribbed construction, taper ground, with free-floating piston pin. High test, high strength cast iron pistons are produced under a patented foundry process. Pistons are provided with seven rings, of which two are the oil scraper type—one on either side of the pin. Modern ring belt design reflects the most recent developments in research and field experience.

CYLINDER LINERS

Enterprise wet contact type cylinder liners are removable and are cast under precise foundry control from a special iron alloy. They are of uniform section, smoothly finished and held to close tolerances. The liners are cooled throughout the entire length of the working stroke, thereby assuring ample heat transfer. Two rubber seals located in the lower section of the cylinder block prevent leakage of cooling water to the crankcase. Allowance is made for expansion of the liner on the lower end.

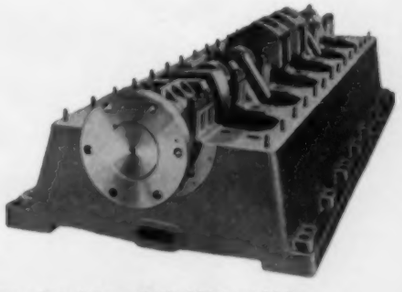
CONNECTING RODS

Connecting rods are of the highest quality drop forged steel, fully machined and finished. They are fitted at the top with bronze bushings. To insure perfect balance of the reciprocating masses, Enterprise connecting rods are statically balanced, both separately and in their complete assembly. Rifle drilled rods provide oil passage the full length to lubricate piston pin bushing from the pressure systems. Connecting rod bolts are stress relieved, magnafluxed, and are of special alloy steel to withstand maximum tension.



CYLINDER BLOCK & CRANKCASE

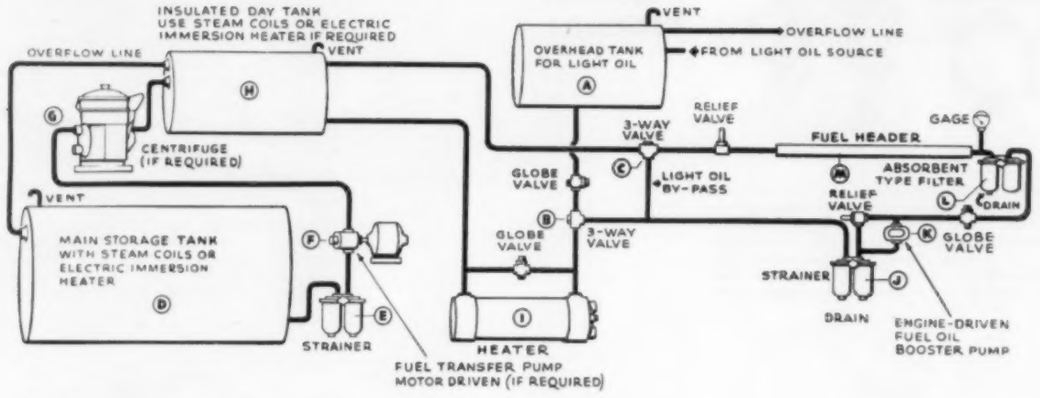
The cylinder block and crankcase are combined in a single casting to insure perfect alignment of all cylinders. The casting is of uniform section and heavily ribbed to provide high strength and rigidity with light weight. Through bolt construction from the top of the cylinder block directly to the bearing cradles in the base absorbs working pressure and relieves the block of the tension stresses. Bearing supports for the camshafts are integral with the block. Large hand-hole plates covering all manifolds, camshaft and the crankcase, permit ready access to all the main and connecting rod bearings, and other working parts.

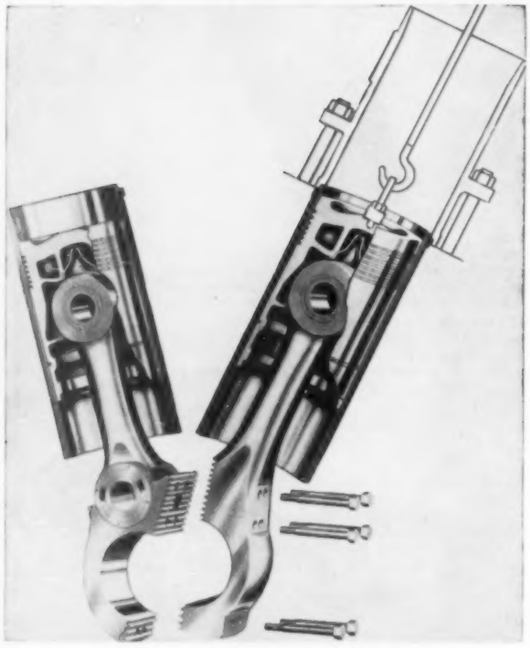


CRANKSHAFT & BASE

All Enterprise crankshafts are forged from single billets of high quality steel. Crankshafts are precision finished to close tolerances, statically balanced, rifle drilled for pressure lubrication of main and connecting rod bearings. To reduce stresses, to decrease unit bearing loads, and to increase rigidity, crankshaft and connecting rod bearing diameters are extremely large. Long bearing life is thereby assured. Longitudinal thrust on the crankshaft is held between a flange turned on the crankshaft and the after-face of the rear main bearing. Base is of rigid construction to assure permanent engine alignment.

PIPING EQUIPMENT DIAGRAM FOR CRUDE AND RESIDUAL FUEL OIL





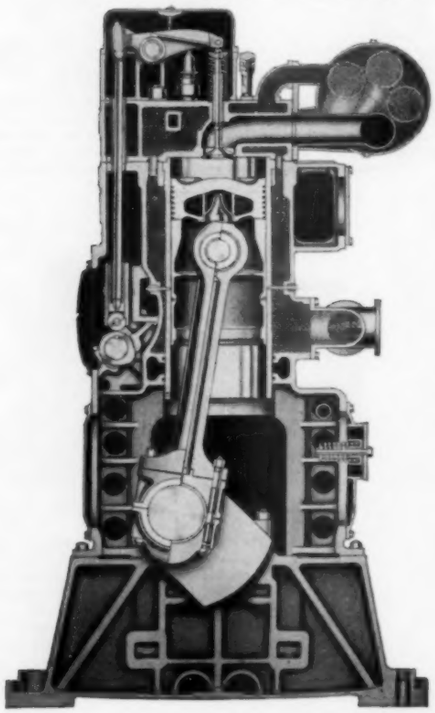
PISTON AND CONNECTING ROD IN NEW ENTERPRISE RV ENGINE

The outstanding advantage of the new Enterprise RV Engine is its size and compactness in relation to its power output. The ratio of horsepower to floor space, or size is greatly improved over that found in other engines of similar rating. Connecting rod design permits opposite cylinders in the V to lie in the same plane, which reduces the over-all length of the engine by more than 20%.

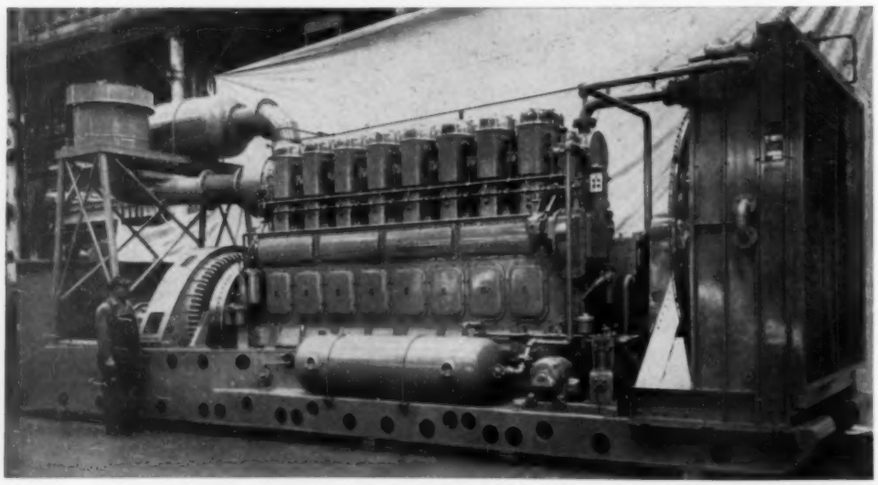
The design of the connecting rod and piston assembly permits the removal of the entire assembly by the release of six clamping bolts and the withdrawal of the assembly through the cylinder liner. A simple piston pulling fixture is provided to facilitate removal of piston and rod.

The rack tooth joint of the master connecting rod distributes the stresses in the joint over the greatest possible area.

SERIES R ENGINE SECTION



ENTERPRISE 1000 KW TRANSPORTABLE GENERATOR SET



Transportable diesel power now provides an immediate source of electricity even in remote areas. Enterprise completely self-contained Diesel generators can be moved anywhere in the world—ready to operate the minute they arrive—providing electric power for building dams, docks, and hundreds of other large construction projects. Also, they are adaptable as permanent stationary power plants for regular, standby or emergency service. For versatile power flexible to your needs, look to Enterprise—the choice of power experts.

ENTERPRISE ENGINES

Bore and Stroke	CYL.	NORMALLY ASPIRATED		TURBOCHARGED		WEIGHT*		STATIONARY			MARINE			
											HEIGHT			
		H.P.	K.W.	H.P.	K.W.	NORMALLY ASPIRATED	TURBO-CHARGED	HEIGHT	LENGTH	WIDTH	Flange to Top	Flange to Bottom	LENGTH	WIDTH
8x10	3	73-162	48-110	137-381	93-267	8,000	8,700	63¾	60	41	58½	6¾	105	43
Model M	4	97-216	65-149	183-508	125-357	10,300	11,100	66¼	67½	41	58½	7½	116	43
450 to 1000	6	146-324	99-225	274-762	189-537	13,200	13,800	63¾	91½	41	58½	5½	140	43
RPM	8	194-432	133-301	366-1045	254-719	16,100	18,000	63¾	115½	41	58½	10¾	186	43
12x15														
Model G	6	273-819	186-577	482-1735	333-1232	38,800	39,900	98¾	146½	58	84	9½	189¾	46¼
250 to 720 RPM	8	364-1092	250-773	643-2313	446-1651	48,000	49,962	98¾	180½	58	84	9½	223¾	46¼
16x20														
Model Q	6	647-1036	450-732	1142-2193	803-1571	87,400	89,600	125¼	197	74	108	16	250	60
250 to 400 RPM	8	863-1381	605-981	1523-2924	1078-2105	105,513	107,913	125¼	245	74	108	16	306	60
17x21														
Model R	6	767-1228	536-870	1354-2888	962-1864	89,900	92,500	125¼	197	74	108	16	250	60
250 to 400 RPM	8	945-1634	662-1166	1805-3852	1282-2496	107,300	109,900	125¼	245	74	108	16	316	60
17x21														
Model RV	12	1228-2455	865-1760	2891-5782	2048-4111	142,600	147,900	145	197	96	145	....	197	96
250 to 400 RPM	16	1640-3280	1162-2322	3852-7703	2731-5502	181,800	189,100	145	245	96	145	....	245	96

*Basic engine with flywheel

NORDBERG

TWO-CYCLE DIESEL ENGINES

NORDBERG two-cycle oil burning Diesel engines for stationary and marine service are built in 21½" and 29" cylinder sizes, with ratings of 510 to 1060 horsepower per cylinder, giving a capacity range of 2550 to 12,800 hp.

Port scavenging system is used for the sake of simplicity and to permit the use of fuels of widely varying characteristics. Referring to Fig. 1, note the automatic scavenging valves inside the scavenging header which control the flow of air from the header to the power cylinders. Valves consist essentially of multiple discs set in cages. They are simple in design, are readily accessible for inspection, and require little or no operating and maintenance attention. These valves permit the inflow of scavenging air after the bulk of the exhaust gases have escaped out the exhaust ports, clearing the cylinder of contaminated gases, and charging the cylinder with clean air ready for the next compression. The whole process is simple and efficient.

General construction of this entire line of engines is identical except for necessary variations due to differences in cylinder size.

ENGINE STRUCTURE consists of the bedplate, columns and cylinder block which are tied together by long tie rods anchored in the bedplate at the sides and below each of the main bearings, and extending to the top of the cylinder block castings. These tie rods take all of the tensile forces created by engine operation and cast iron parts are always under compression. The whole construction forms a single rigid unit. Box design bedplate is divided into separate compartments by ribbed bridges machined to receive and support main bearing shells. Bearing shells are of two piece removable shell type lined with centrifugally cast anti-friction metal. Columns rest transversely on bedplate over each main bearing. Individual cylinder castings are bolted together front and rear providing a rigid construction. Cylinder liners are removable and have ports on opposite sides for scavenging and exhaust respectively. These ports register with passages in the block which connect with the scavenging manifold and exhaust header.

CYLINDER HEADS, as shown in Fig. 1, are of simple design and made of special Nordberg heat-treated cast iron. Fuel injection valve is in the center. Clean-out openings are provided permitting the removal of scale or sediment which may accumulate due to impurities in the cooling water.

CRANKSHAFT is made of forged steel, completely machined and made in one or two pieces according to engine size. Proportions are substantial and shaft is drilled for lubrication and piston cooling purposes.

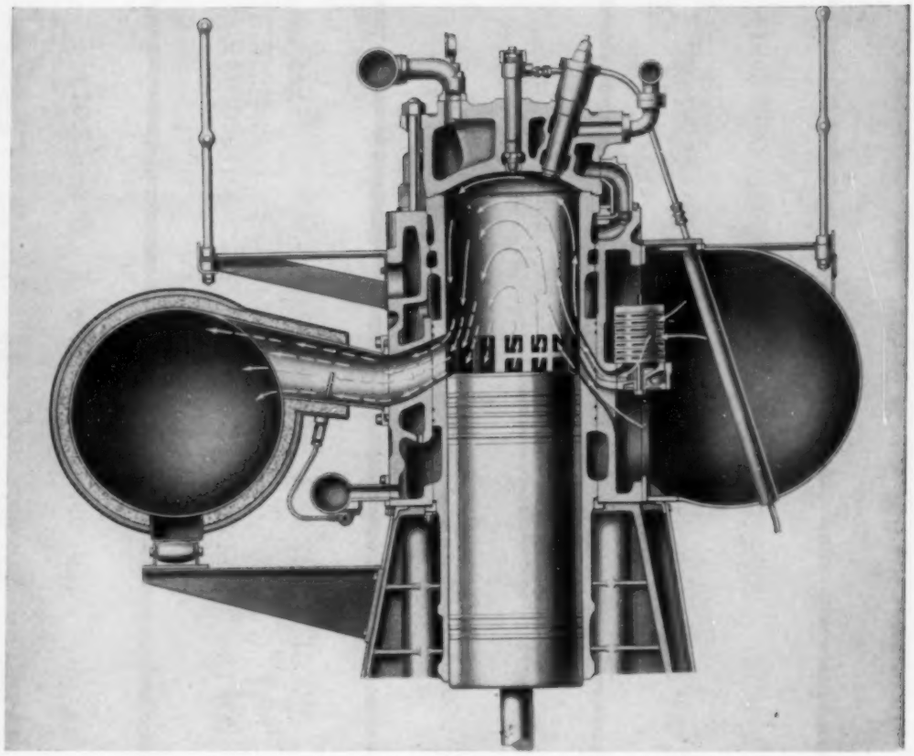
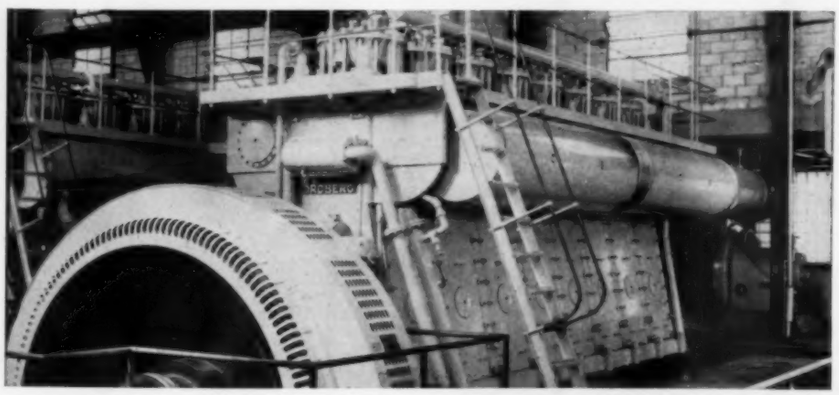


Fig. 1. Nordberg system of scavenging showing the path of air from the manifold through the scavenging valves and ports into the cylinder. With the air deflected upward, the cylinder is filled with clean, cool uncontaminated air, the exhaust gases having been forced out through the exhaust ports.

PISTONS are of two-piece construction; head carries piston rings and contains cooling arrangements. Skirt or trunk is bolted to head. Trunk type engines have the wrist pin bolted to bosses within the piston trunk.

SCAVENGING AIR—Nordberg engines are furnished with either attached or motor-driven blowers for scavenging. The system of scavenging is described and illustrated in Fig. 1. Attached blowers are gear driven from the engine crankshaft.

FUEL INJECTION is by individual pumps mounted directly above the camshaft and driven from it. Fuel pumps are adjacent to the cylinders they serve. Fuel injection valve is in the center of the head. Pumps are of constant stroke plunger type; governor control is arranged to by-pass fuel not required for engine load. Since one of the attributes of the Diesel engine is its ability to produce power cheaply, Nordberg engines may be operated on a wide variety of fuels, and especially heavy, low grade fuel oil. With the proper heating



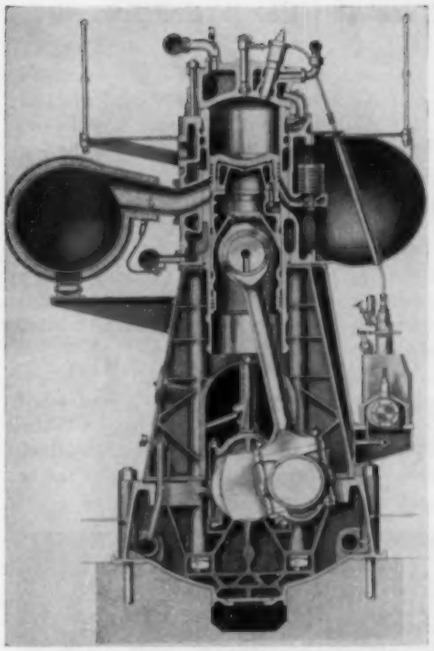
Two Nordberg two-cycle, eight cylinder, 21½" bore Diesel generating units burning heavy fuel oil.

and cleaning devices, these engines will operate on fuel oils as low as 10 degrees A.P.I. gravity.

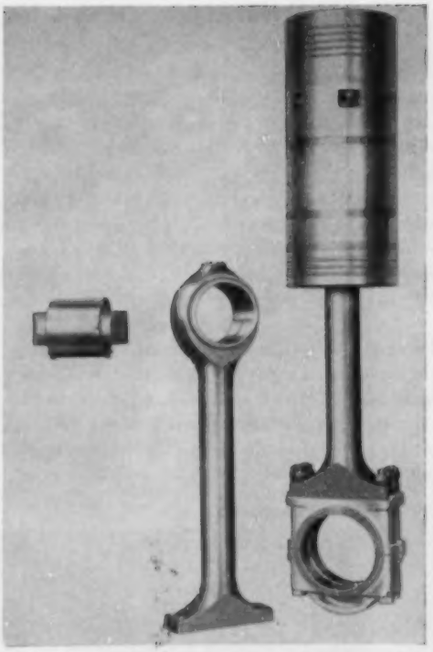
GOVERNORS are hydraulic relay type. Speed variation from no load to full load is adjustable from 0 to 5 per cent for gradual change in load. Governor is equipped with dials for adjusting the load limit, the speed regulation, and the change in speed needed for synchronizing.

LUBRICATION AND PISTON COOLING are accomplished by a circulating system which delivers oil under pressure to a large header located in bedplate. Leads from this header deliver oil to all bearings and working parts of the engine. Both webs of each crank are drilled to conduct oil to the crankpins and wrist pins, and then to the oil-cooled piston heads; connecting rods have a large drilled passageway their full length. All oil returns to the sump in the bedplate, from which it is pumped to an oil cooler, and strainer or filter, and again delivered to the oil header in the bedplate. Power cylinder lubrication is accomplished by multiple pump timed lubricators supplying oil to the upper end of the cylinders at several points on the periphery of the liners. Lubricators, one for each cylinder with a separate pump for each feed, are timed to deliver oil to the piston when it has reached a predetermined position in the cylinder.

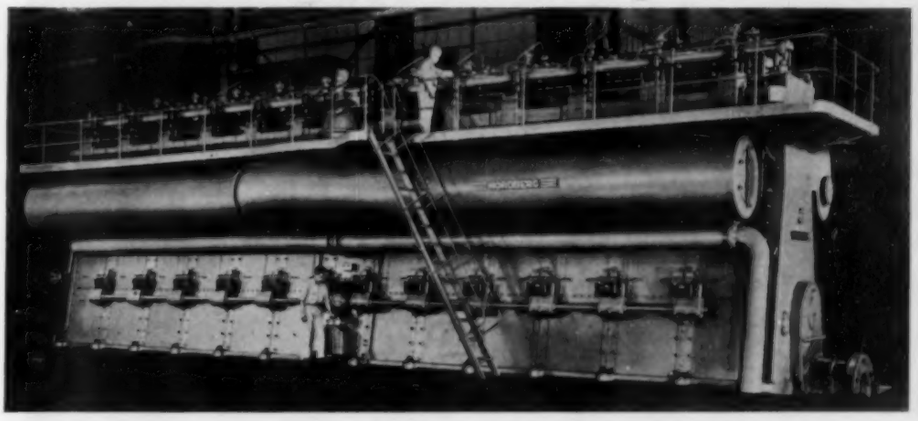
ACCESSIBILITY to parts inside the crankcase is afforded by the frame design and construction, and in addition, attention has been given to equal accessibility to all other working parts. Spaces between adjacent columns are enclosed by removable covers, which are oil and dust tight, and, being flat and smooth, are easily kept clean. When removed, the full space between the columns is available for access to parts within the crankcase.



Section through the power cylinder of a mechanical injection engine of trunk piston design.

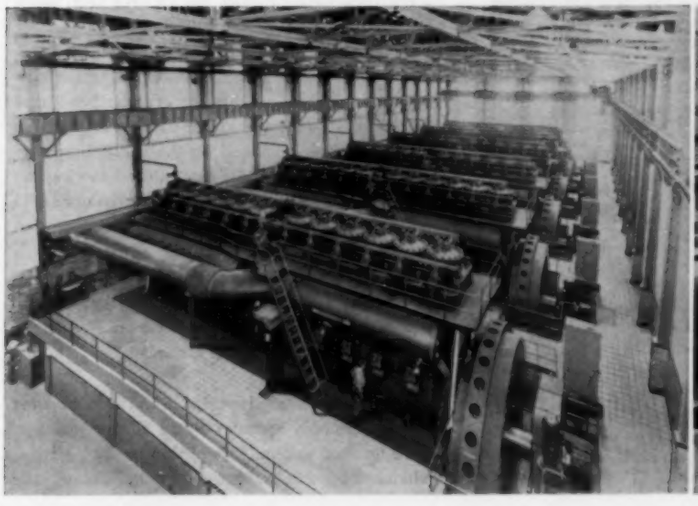


Left—View of wrist pin and connecting rod. Right—Trunk piston, connecting rod and bearing assembly.

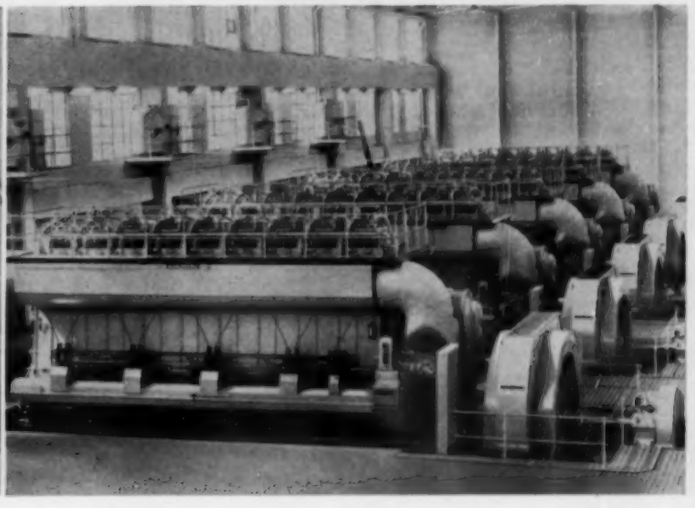


The Nordberg twelve cylinder, two cycle engine with 29" bore and 40" stroke—like the one pictured here—is rated 12,800 hp at 200 rpm.

Six Nordberg two-cycle, 29" bore, 12 cylinder Diesel engine generating units produce electric energy in a large utility power plant in Mexico.



Five Nordberg two-cycle, 21½" bore, nine cylinder Diesel engine generating units produce power for Australian zinc mining and milling operations.



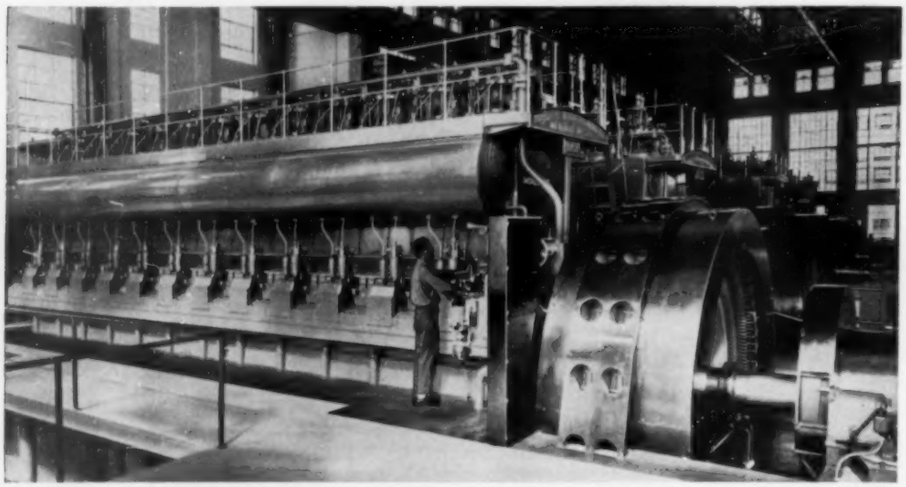
NORDBERG TWO-CYCLE DUAFUEL DIESELS

Nordberg two-cycle Duafuel® Diesel engines are convertible to oil or natural gas operation. They have the same design and construction as the regular line of oil burning engines and are available in 21½" and 29" cylinder sizes. Engines operate on the Diesel principle when burning either gas or fuel oil, and can be furnished either as instantaneously convertible dual fuel type or as convertible units requiring a short shut-down for the change-over.

Two types of gas admission systems are available: low pressure and high pressure. In the low pressure system, the cylinder is scavenged and charged with air in the normal manner. Gas is admitted through the gas valves at about 20 psi after the scavenging and exhaust ports are closed, at the beginning of compression. Then the mixture of gas and air are compressed to approximately 500 psi. Pilot fuel oil is injected into the combustion space near the end of the compression stroke and is ignited by the heat of compression. This burning pilot oil ignites the gas and air mixture, and the remainder of the cycle follows through in the regular manner.

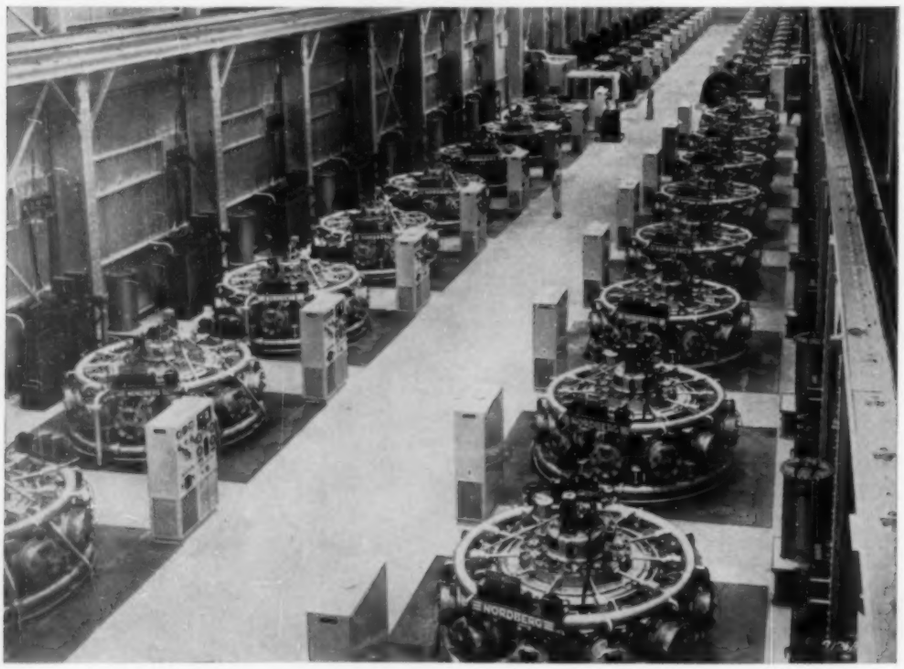
In the high pressure system, the gas, supplied by a compressor, is admitted to the cylinders at the end of the compression stroke with the pilot oil injected simultaneously.

Nordberg instantaneously convertible Duafuel Diesel engines operate in either of the two following ways: (1) Gas fuel plus pilot oil. (2) Fuel oil. By means of a simple control, the engine can be set to operate under either of these two conditions while under load without stopping the engine. Should there be a failure of supply of either fuel, the engine can be shifted immediately to the other fuel. Thus with the Nordberg Duafuel engine it is always possible to burn the fuel that is more economical or more readily available. An automatic control is available to change over instantaneously in event of gas pressure failure.



Nordberg two-cycle, 12 cylinder, 21½" bore DUAFUEL engine in a municipal power plant.

Forty Nordberg Gas Burning Radial Engines providing low cost electrical power for a large aluminum reduction plant. The entire power station has 220 Nordberg Radial Engines, totalling more than 400,000 horsepower.



Nordberg Radial Engines

The Nordberg Radial engine is built as an oil burning Diesel engine, as a spark fired gas engine with superior patented system of spark ignition and as a Duafuel engine. This engine is of the two-cycle type with 14 inch bore and 16 inch stroke, rated from 2125 to 2520 horsepower. Turbocharging has also been developed where greater outputs are desirable. It is arranged for port scavenging and port exhaust, the intake and exhaust being timed by the pistons as they uncover the ports in the cylinder walls, thereby eliminating intake and exhaust valves.

The engine is furnished with a gear set to drive the attached scavenging blower, exciter, lubricating oil pump, and water pumps. If desired, the above equipment can be furnished with separate motor drive. The circular exhaust manifold is located beneath the grating at engine room level. The crankshaft, made of high tensile alloy cast iron, is set vertically with the single crank at the top. The generator, or other driven equipment, is mounted below in the coolest zone. The cylinders are located in a horizontal plane and are bolted radially to the frame. This frame is a single casting of symmetrical design having a central hub which carries the lower crankshaft main bearing and the Kingsbury type thrust bearing which carries the weight of the crankshaft, generator shaft and generator rotor. The cover bolted to the top of the frame is also of symmetrical design and contains the upper crankshaft bearing. Mounted on top of this cover are the governor, operating mechanism for the gas valves if the engine burns gas, or the fuel pumps if the engine burns oil.

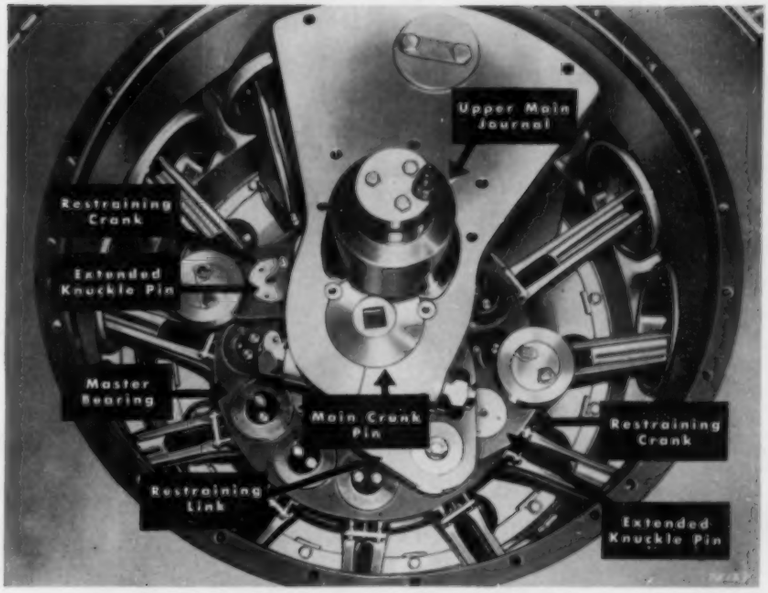
When the Nordberg Radial engine burns oil, it operates on the Diesel principle with normal compression and is arranged for mechanical injection of the fuel. Each cylinder has its own fuel pump which is located in a horizontal position directly above the cover. All pumps are actuated by a single cam on the crankshaft. The fuel injection nozzles are centrally located in the cylinder heads and all fuel lines from pumps to nozzles are of the same length. Speed is regulated by the hydraulic governor acting directly on the fuel pumps, varying the amount of fuel delivered to the injection nozzles as the load of the engine varies. The engine is started with compressed air. When the control lever is moved to the starting position, air is admitted to the air distributor which actuates the starting valves in all cylinder heads. This method of starting is simple and positive in action.

The Nordberg Radial engine when arranged for gas burning only operates on an advanced design spark ignition system. In addition to the ports for exhaust and intake, each cylinder has a cage

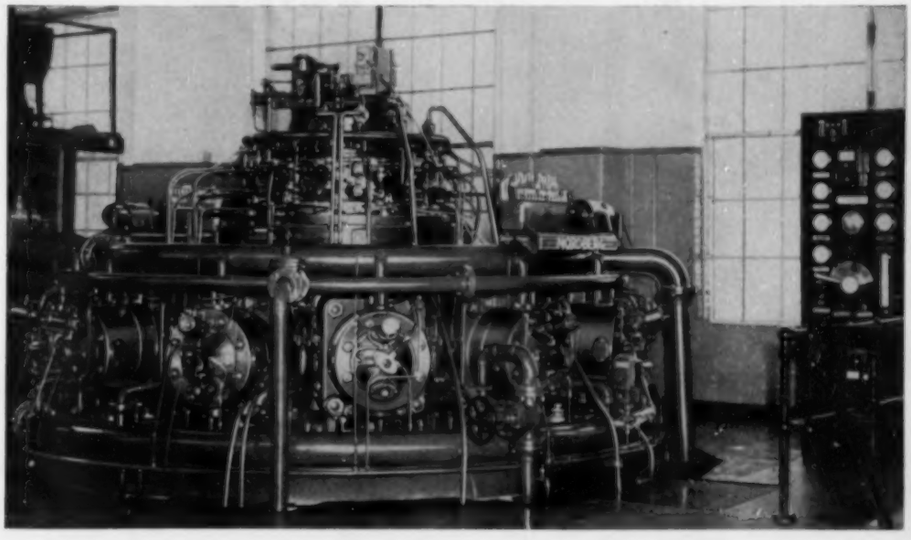
mounted gas valve for admitting the gas fuel. These valves are actuated by rocker arms and push rods which in turn get their movement from a cam on the crankshaft. These gas valves are so located that the gas is admitted into the path of the incoming scavenging air to assure thorough mixing and the most efficient utilization of fuel. A valve inserted in the gas line and connected to a hydraulic governor automatically varies the amount of gas delivered to cylinders as the load on the engine varies.

The Nordberg Radial Duafuel Diesel engine operates on either fuel oil or natural gas as an instantaneously convertible engine burning (1) gas fuel plus pilot oil, (2) fuel oil only. The engine can be set to operate on either fuel by means of a simple control while the engine is under load and without stopping it. An automatic control is available to change over instantaneously in event of gas pressure failure.

Among the unusual design features of the Nordberg Radial engine is the patented method whereby the forces exerted by the pistons are conveyed to the crankpin through a master bearing. The master bearing is restrained from rotating; instead it gyrates around the center line of the crankshaft resulting in the same motion for each connecting rod and piston. This unique design results in an inherently balanced engine which is not possible with the master connecting rod design commonly associated with other radial engines. Another unusual feature is found in the design of the bearings which are all renewable bushings easily replaced at minimum expense. There are no split bearings in the engine.



Top view of Nordberg 12 cylinder Radial engine with cover removed showing patented master bearing linkage which is responsible for engine's excellent balance.



Nordberg 12 cylinder DUAFUEL Radial engine generating unit installed in a municipal power plant.

NORDBERG TWO-CYCLE DIESEL AND DUAFUEL ENGINES

Model Number	Cycle	No. of Cylinders	Horsepower	R.P.M.	Starting
RTS-1412	2	12	2125-2520	400-450	Air
TS-215-31	2	5	2550-2925	240-257	Air
TS-216-31	2	6	3050-3500	240-257	Air
TS-217-31	2	7	3575-4100	240-257	Air
TS-218-31	2	8	4075-4675	240-257	Air
TS-219-31	2	9	4600-5275	240-257	Air
TS-2110-31	2	10	5100-5850	240-257	Air
TS-2112-31	2	12	6150-7025	240-257	Air
TS-296	2	6	5670-6400	189-200	Air
TS-297	2	7	6620-7500	189-200	Air
TS-298	2	8	7570-8500	189-200	Air
TS-299	2	9	8500-9600	189-200	Air
TS-2910	2	10	9450-10600	189-200	Air
TS-2912	2	12	11350-12800	189-200	Air

Supairthermal In-Line Diesel and Duafuel Types

Nordberg Supairthermal® Diesel engines are built with 6 and 8 cylinders in the Series 9 engines and with 5, 6, 7 and 8 cylinders in the Series 13 engines for both marine and stationary service.

BEDPLATE is one piece casting of fine-grain high-tensile cast iron extending the length of engine and serves as lower half of crankcase. Heavily ribbed and transverse sections provide rigid support for the crankshaft and bearings. Broad flanges and bosses along the sides provide a rigid means for bolting and securing engine to foundation.

FRAME is single casting of alloy iron, and serves as upper crankcase and enbloc cylinder housing combined, as well as forming a sturdy structure for mounting of accessories. Frame is held securely to bedplate by means of tie rods anchored in the bedplate on either side and below each main bearing and extending to the upper portion of frame. Tie rods relieve frame and bedplate of tension stresses set up during operation of the engine. Bedplate and frame together give a rigid structure assuring permanent alignment of engine parts. Large cored spaces in frame provide for efficient jacketing and circulation of cooling water around cylinder liners. Cylinder liners of removable wet type are made of fine-grain cast iron and precision finished in the bore. Sealing rings insure water tight joint at the lower end in the frame.

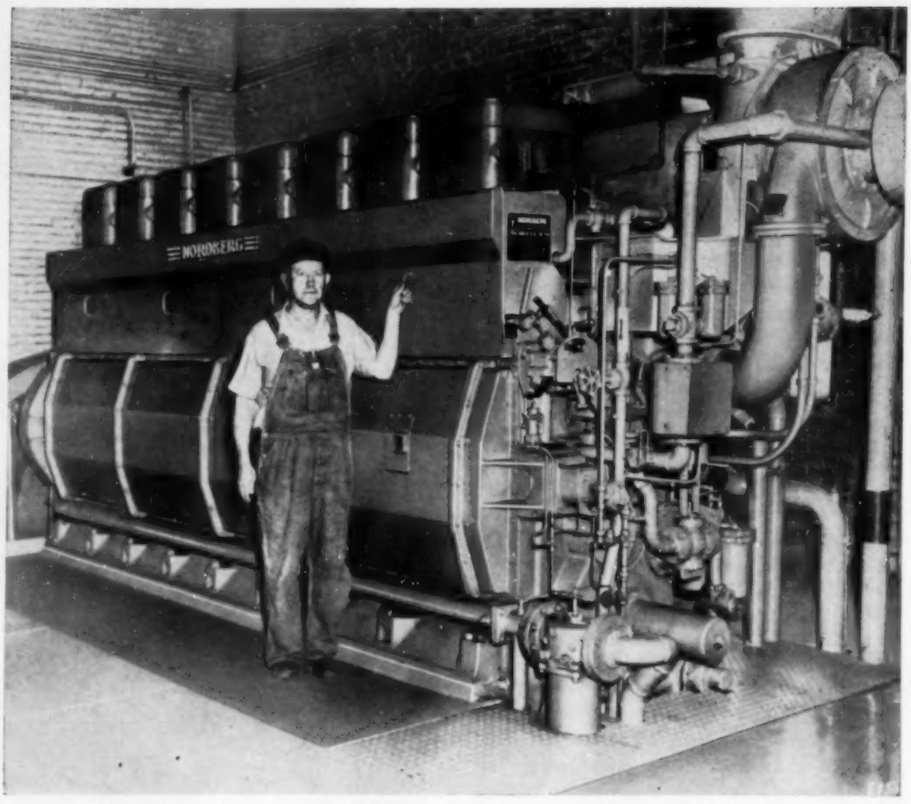
CRANKSHAFT is forged from high grade carbon steel, with bearing surfaces precision finished and polished, and shaft is drilled for pressure lubrication from the main to the crankpin journals. Oil holes are located in the minimum pressure zone of the crankpin circumference.

CONNECTING ROD is a high-carbon heat-treated steel forging designed as an H-section for uniform column stress in both planes.

PISTON is cast from heat and wear resisting alloy iron. Pistons for the Series 9 engines have three compression rings and two oil control rings and pistons for the Series 13 engines are provided with four compression rings and two oil control rings.

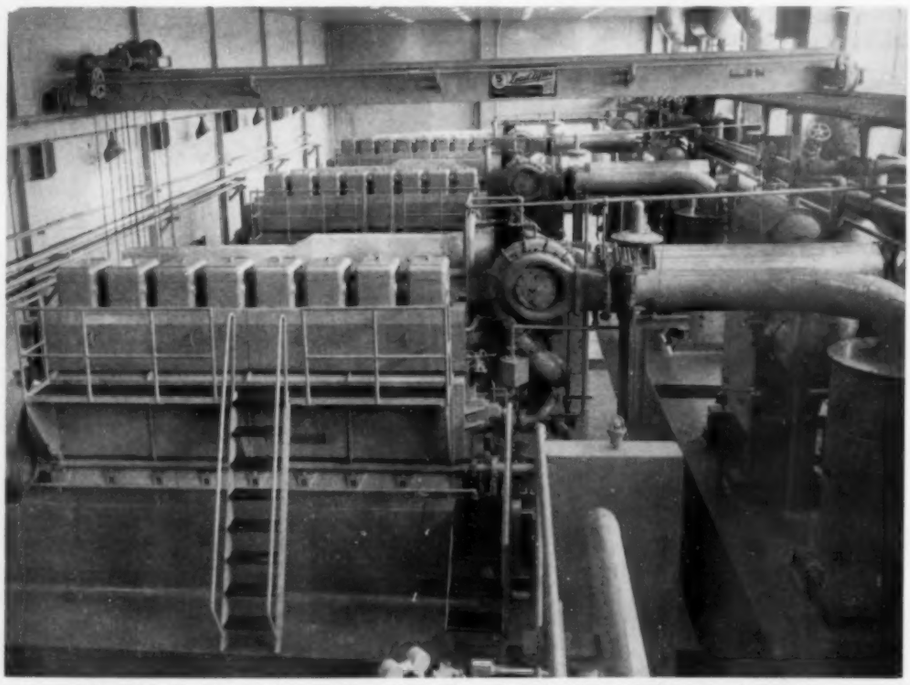
CYLINDER HEADS are individual castings from heat-resisting gray iron alloy, and are secured to the frame with four studs. Combustion chamber is of open type resulting in efficient combustion and smooth operation. Each cylinder head has one intake and one exhaust valve made of heat-resisting and non-corrosive steel with stems chrome plated to provide long life, and top of stems hardened and ground.

Individual valve lever housings, cast from fine-grain iron, are secured to the cylinder heads by studs, and contain the valve lever shaft and rocker arm assemblies. Cast aluminum covers fully enclose the valve lever mechanism and permit ready access for inspection.



Nordberg 8 cylinder, 13"x16½" Supairthermal Duafuel engine in a municipal power plant.

CAMSHAFT is precision ground and polished with cams shrunk on. Cams are case hardened and accurately ground to contour. Timing gears are located at flywheel end of engine to eliminate undue torsional stresses and wear on the gear train. Camshaft is supported in bearings secured to the engine frame and pressure lubricated by



Three Nordberg 8 cylinder, 13" bore, Supairthermal engines in a pipeline pumping station. A total of 12 of these engines are in service along the pipeline.

means of drilled passages from the oil header within the frame. Push rods actuating the valve levers are enclosed in tubular steel castings which fit into the cylinder block.

FUEL INJECTION PUMPS are individual for each cylinder and are mounted above the camshaft at the side of the frame adjacent to their respective cylinders. Fuel lines leading to fuel injectors in the cylinder heads are short and of uniform length. Pump fuel racks are connected to control shaft, which in turn is connected to the governor mounted at the flywheel end and driven by gears from the camshaft gear train. Gear type fuel booster pump is engine driven.

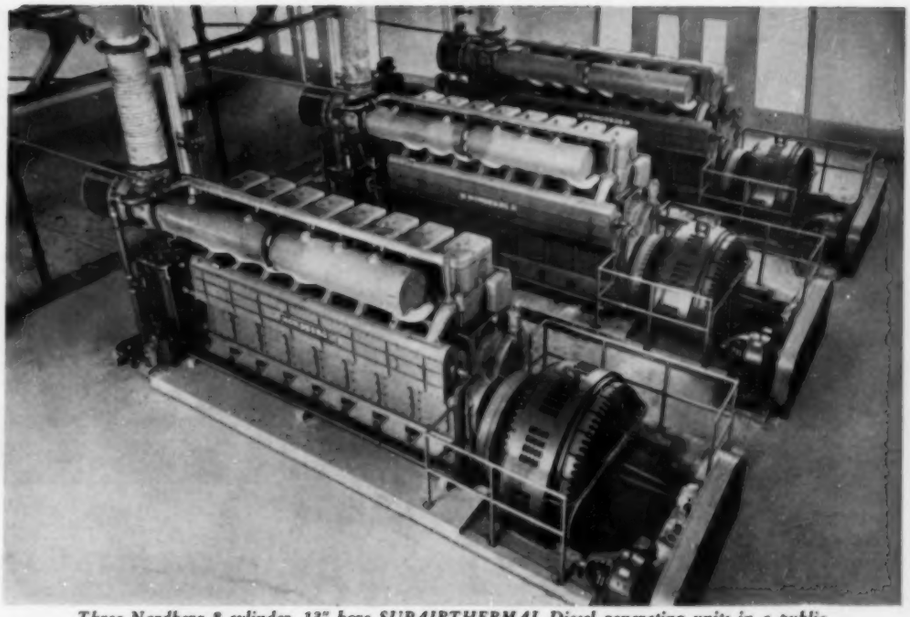
LUBRICATING OIL is drawn by either an attached or motor driven lubricating oil pump from the sump and passes through the strainer and cooler into the main distributing manifold. Drilled oil passages conduct the oil under pressure to various parts of the engine, reducing the number of oil lines required. Crank webs are drilled to supply an uninterrupted flow of oil to crankpin bearings.

Piston pins and piston cooling jets are supplied with oil from the connecting rod passages.

COOLING SYSTEM includes attached or motor driven centrifugal pumps for raw water and for jacket water.

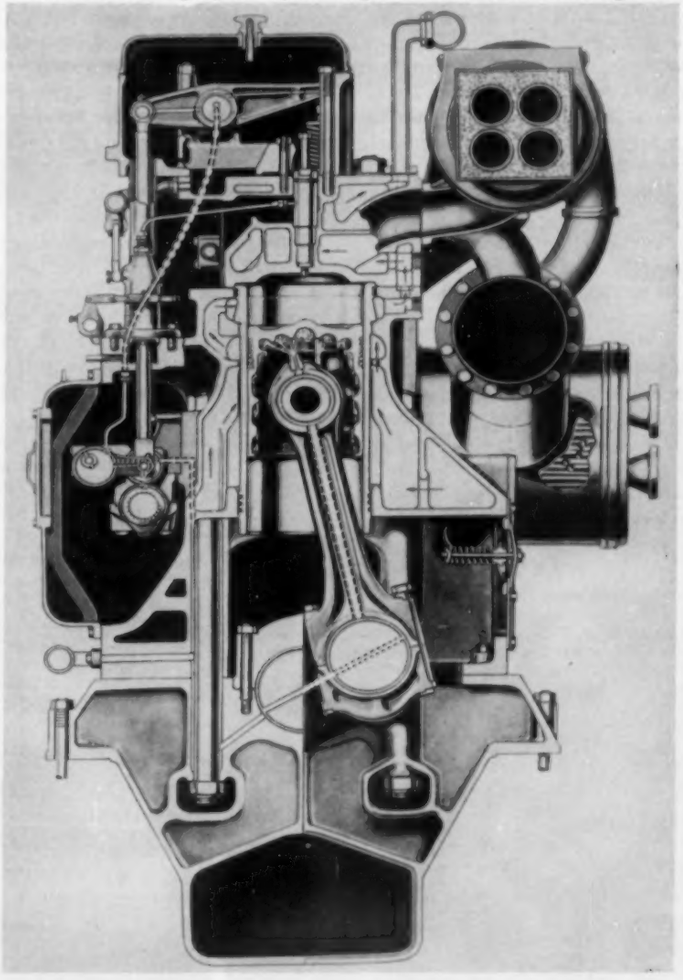
STARTING is by compressed air with an air starting valve in each cylinder head. Air starting distributor driven from the camshaft times the cylinder head starting valves pneumatically. A header connection supplies compressed air to each starting valve.

SUPAIRTHERMAL engines have a turbocharger mounted on the engine. Turbochargers are lubricated by a separate lubricating oil system, including a filter, cooler, motor driven pump and automatic controls. Turbocharger turbine casing is cooled by connections from the engine cooling system.



Three Nordberg 8 cylinder, 13" bore SUPAIRTHERMAL Diesel generating units in a public utility power plant.

Cross section through cylinder of Nordberg SUPAIRTHERMAL Diesel engine.

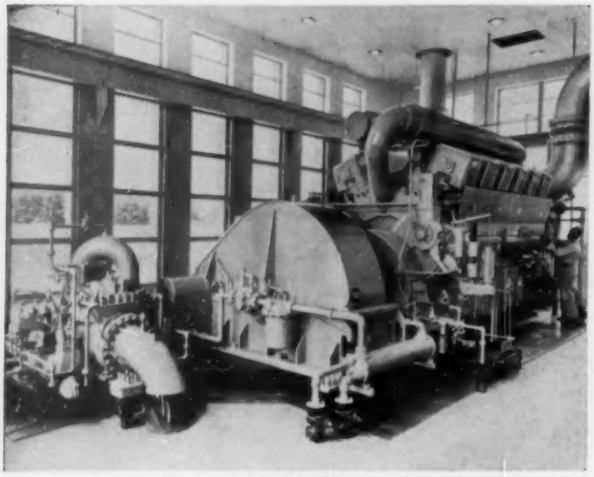


NORDBERG V-TYPE SUPAIRTHERMAL ENGINES

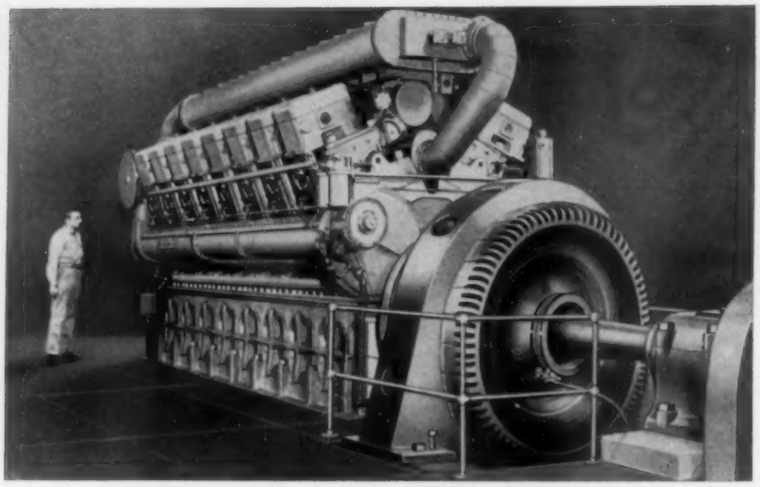
Nordberg 10, 12 and 16 cylinder, Series 13 SUPAIRTHERMAL V-Type engines are designed to meet the increasing demand for a high power, heavy duty engine of moderate weight and small dimensions. The design incorporates all of the tested and proven performance features of the Nordberg Series 13 in-line SUPAIRTHERMAL engine and many of its important parts are identical and interchangeable with the in-line type engine.

With its wide horsepower range and high efficiency, the Nordberg V-Type engine is exceptionally well suited for continuous, economical operation in a wide variety of power applications.

The compact design and high horsepower ratings of the Nordberg V-Type Diesel engine make it ideally suited for marine propulsion service. Installation of this engine will provide more horsepower and result in substantial savings in space and weight. Nordberg V-Type marine Diesel engines are available for all types of marine drive, including direct reversing.



Nordberg 4-cycle, 12 cylinder SUPAIRTHERMAL V-Type engine driving a centrifugal pump on a products pipe line.



Nordberg four-cycle, 16 cylinder Supairthermal V-Type engine.

NORDBERG SUPAIRTHERMAL ENGINES

The Nordberg SUPAIRTHERMAL engine's most notable characteristic is its ability, in any given size, to produce more horsepower than the conventional supercharged engine with no greater heat to the cooling water and without increasing the internal surface temperatures.

The Nordberg SUPAIRTHERMAL engine, latest of the advancements in diesel engine performance, uses the "Miller System of Supercharging" and improves upon the ordinary turbocharged engine in four important ways.

First, a greater amount of air cooling within the cylinder is accomplished by blowing a larger volume of cooler air through the cylinder and out the exhaust pipe.

Second, the turbocharger delivers air to the cylinder at a higher pressure, thus providing more weight of air and making it possible to burn more fuel.

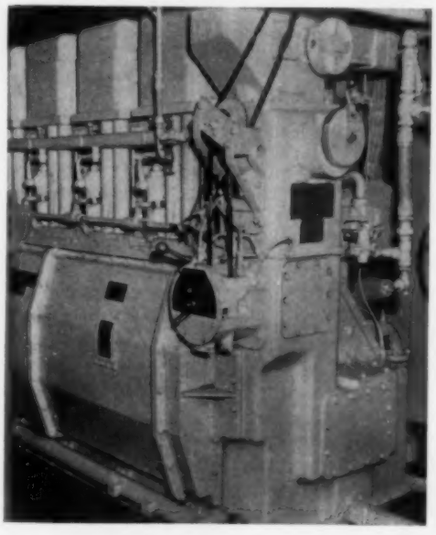
Third, by means of an intercooler on the discharge side of the turbocharger, the temperature of the intake air is cooled before it enters the cylinder.

Fourth, by closing the intake valve before the end of the intake stroke, the air within the cylinder is expanded at full load and the intake air is thereby cooled within the cylinder.

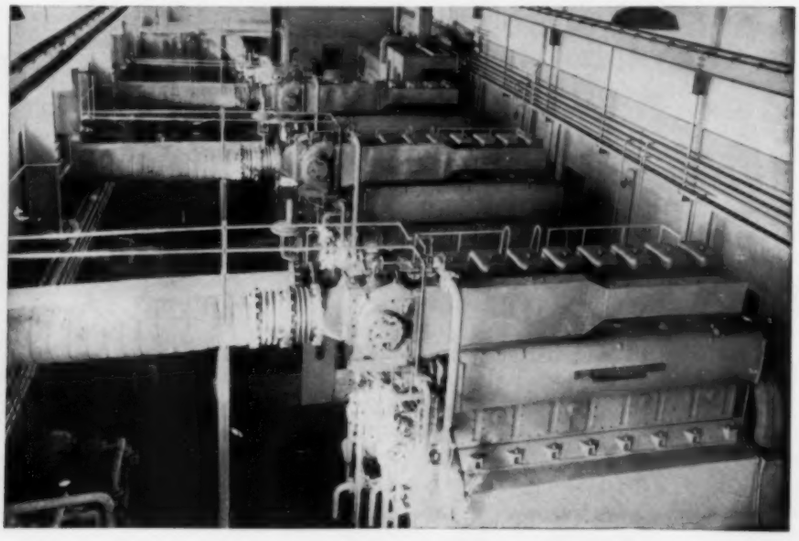
With the increase in power, the SUPAIRTHERMAL engine has greater thermal efficiency, more power in less space, more horsepower per gallon of fuel, more horsepower hours per gallon of lubricating oil, less weight per horsepower, less heat loss to the water jackets and will cost less per horsepower for engine installation, operation and maintenance.

Nordberg Supairthermal engines are also offered for dual fuel operation. For locations where gaseous fuel of any kind is available at attractive rates, on a firm, interruptable, off-peak, or seasonal basis, Nordberg DUAFUEL® engines offer many advantages. The Nordberg Duafuel engine can be operated on gas with only a small percentage of pilot oil, or 100% fuel oil. In case of any interruption in gas supply the engine will automatically change to full oil operation without affecting speed or load.

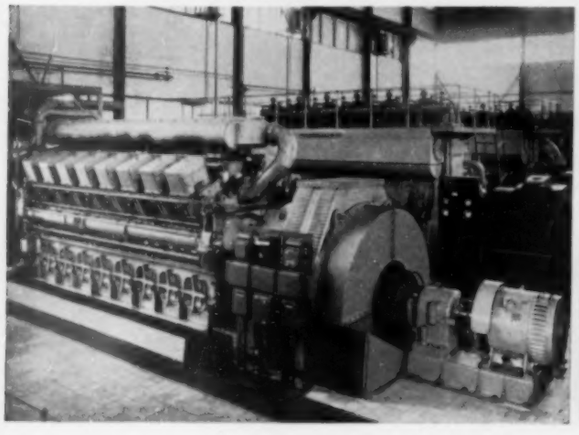
One of two Nordberg direct reversing Supairthermal marine diesels in the engine room of a 103' towboat.



Nordberg four-cycle Supairthermal Duafuel engines in pipe line pumping service.



Nordberg 16 cylinder, V-Type Supairthermal Diesel operating in a public utility power plant. In the background are three Nordberg 2-cycle, 21" bore, six cylinder engines.



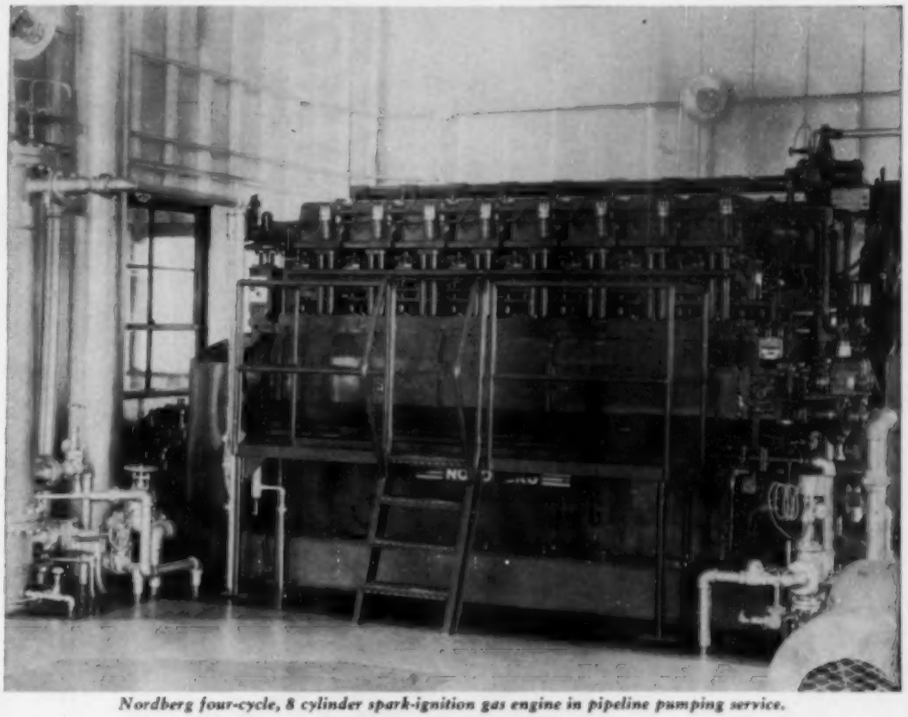
FOUR-CYCLE SPARK-IGNITION GAS ENGINES

Nordberg Spark-Ignition Gas Engines are offered in the Series 9 and Series 13 sizes as Supairthermal engines covering a range of 640 to 4350 horsepower.

These four-cycle engines economically burn natural gas, butane, propane, manufactured gas and sewage gas. Other gases of lower BTU content can also be used, but at reduced ratings. The spark-ignition gas engines have the same basic heavy-duty construction features of Nordberg four-cycle Diesel engines.

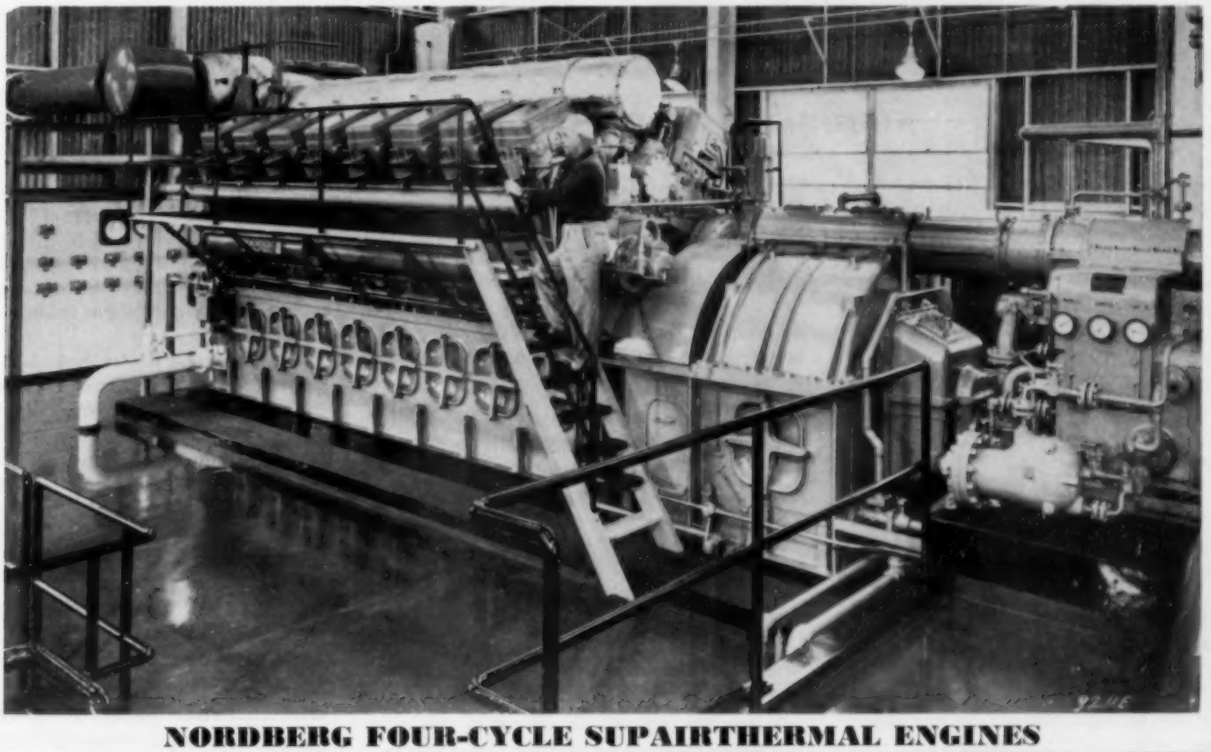
Outstanding among the operating advantages of all Nordberg spark-ignition gas engines is their high thermal efficiency. This high efficiency is the direct result of expansion ratios up to 12 to 1 and controlled compression ratios by variable inlet valve timing.

Another innovation has been the addition of a speed increasing gear built into an extension of the bedplate as illustrated below. Coupled with the Supairthermal spark-ignition engine, it affords a compact efficient prime mover for use with centrifugal compressors for gas pipe line service. All of these engines are equipped with modern ignition systems, the latest methods of turbocharging, and are being used in all types of service, both constant and variable speed.



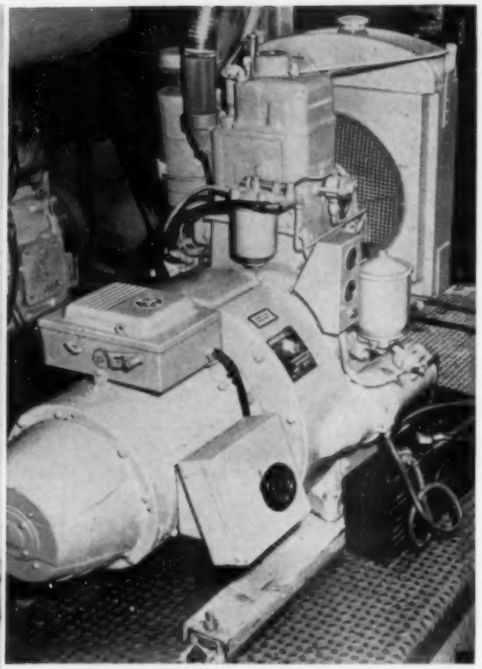
Nordberg four-cycle, 8 cylinder spark-ignition gas engine in pipeline pumping service.

Nordberg V-Type, 16 cylinder spark-ignition gas engine driving a centrifugal gas compressor through a Nordberg speed increasing gear in gas pipeline compressing service.



NORDBERG FOUR-CYCLE SUPAIRTHERMAL ENGINES

DIESEL-DUAFUEL					SPARK-FIRED GAS				
Number of Cylinders	Bore	Stroke	Horsepower	R.P.M.	Number of Cylinders	Bore	Stroke	Horsepower	R.P.M.
6	9"	11½"	640	720	6	9"	11½"	640	720
8	9"	11½"	850	720	8	9"	11½"	850	720
5	13"-13¼"	16½"	1000-1350	450-514	5	13"-13¼"	16½"	1000-1350	450-514
6	13"-13¼"	16½"	1200-1625	450-514	6	13"-13¼"	16½"	1200-1625	450-514
7	13"-13¼"	16½"	1400-1900	450-514	7	13"-13¼"	16½"	1400-1900	450-514
8	13"-13¼"	16½"	1600-2175	450-514	8	13"-13¼"	16½"	1600-2175	450-514
10	13"-13¼"	16½"	2000-2500	450-514	10	13½"	16½"	2000-2500	450-514
12	13"-13¼"	16½"	2400-3000	450-514	12	13½"	16½"	2400-3000	450-514
16	13"-13¼"	16½"	3200-4000	450-514	16	13½"	16½"	3200-4000	450-514



Nordberg Power Chief 6 KW Diesel Generator Set furnishes light and power for oil field drilling rig.

Nordberg Power Chief 4FGI Gas engine in oil field pumping service.

NORDBERG "POWER CHIEF" ENGINES

Nordberg POWER CHIEF Diesel and Gas Engines are simple and compact, designed for continuous heavy-duty service. They are built with one, two, or three cylinders of 4½" bore and 5¼" stroke. The diesel engines are arranged for mechanical injection and operate on regular diesel fuels. The POWER CHIEF gas engines are designed for oil field service and can be supplied with straight gas or combination gas-gasoline carburetors.

Both the diesel and gas engines are furnished complete, self-contained, ready to operate in the following combinations:

1. With stubshaft for direct connection.
2. With clutch power take-off for direct connection or belt drive.
3. With electric generator for either direct or alternating current.

CYLINDER BLOCK is a single casting of alloy iron, heavily ribbed to provide maximum rigidity, which is bolted to the top of the base. Removable wet type liners are of fine grain, alloy iron, cast by a special centrifugal process. The bore is surface treated to improve lubrication.

CYLINDER HEADS are made of special alloy cast iron. Each cylinder has individual cylinder head. The exhaust valves are of silichrome steel and seat on removable inserts. The inlet valves are of alloy steel. Rocker arms of forged alloy steel are mounted on a hollow steel shaft. A cylinder head cover completely encloses the valve mechanism and carries the compression release for easy cranking.

BOX TYPE BASE contains the sump for lubricating oil system. It is made of cast iron with flat bottom and bosses for easy mounting and securing to foundation. Cylinder block is bolted to the base. Adequate hand holes with covers are provided for easy inspection and access to the connecting rod bearings, main bearings, oil pump and oil suction strainer.

CRANKSHAFT is a special alloy casting, precision ground, counter-balanced and drilled for pressure lubrication. It is suspended from the cylinder block and held securely with large bearing caps. The main bearings are removable steel shells lined with anti-friction metal.

PISTONS are fitted with three compression and two oil control rings. The top compression ring is chrome-plated for long life. The piston pin is of the full floating type, hardened and ground and securely held in place by means of retaining rings.

CONNECTING ROD and cap are die forged in one piece of heat treated steel and drilled for pressure lubrication of the piston pin. The cap is secured to the rod by four heat treated alloy steel bolts. The crankpin bearings are steel shells lined with anti-friction metal.

CAMSHAFT is of forged steel with precision ground cams and bearings. Camshaft is driven from the crankshaft by helical gears.

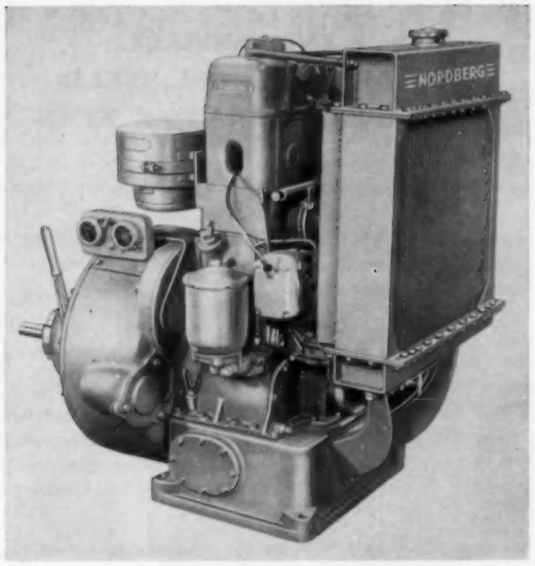
Fuel System

Diesel Engines—The gear type positive displacement pump has a built-in pressure relief valve. Individual fuel injection pumps for each cylinder are provided to deliver fuel at high pressure through heavy steel tubing to the injection nozzles.

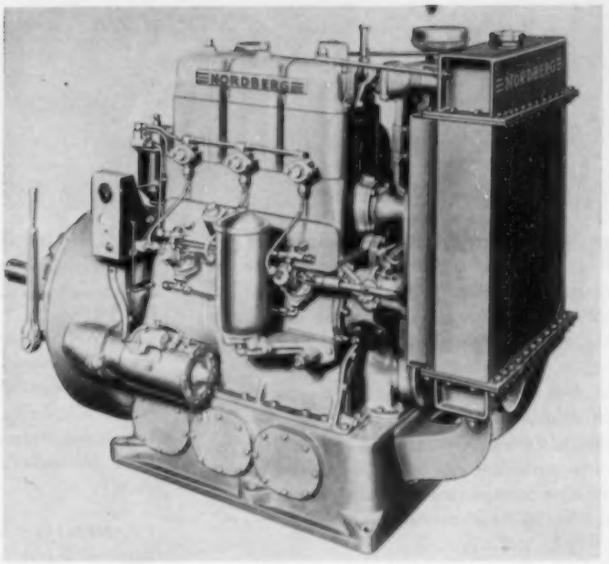
The fuel injection nozzles, located in the side of each cylinder head for accessibility, are of the self-cleaning type with a single orifice in the nozzle tip.

Gas Engines—Either a gas carburetor or combination gas-gasoline carburetor can be provided on the engine. In either case, an engine-mounted gas regulator is provided to reduce incoming gas pressure to 4 to 6 oz.

LUBRICATION—Full pressure lubrication is provided to main, connecting rod, piston pin, and camshaft bearings and to rocker arms and other working parts of the valve mechanism. Circulation of oil is maintained by a gear type lubricating oil pump located in the oil sump in the engine base, and an adjustable lubricating oil relief valve is provided. Oil enters the suction side of this pump through a float strainer, and then passes to the lubricating oil cooler. The oil is then conveyed to various bearings by means of large internally drilled passageways in the crankcase, crankshaft and connecting rod. A by-pass type, replaceable cartridge lubricating oil filter is standard equip-



Nordberg Power Chief 4FG1 Spark Fired Gas engine for oil field pumping service.



Nordberg Power Chief 4FS3-BE Diesel engine with clutch power take off. Power units are available with one, two or three cylinders and are rated 10 to 45 hp.

ment on these engines to maintain clean oil at all times.

GOVERNOR—A mechanical flyball type governor, gear driven, regulates the amount of fuel delivered in accordance with the load on the engine. Speed regulation of 3% or better from no load to full load insures accurate speed control, and a simple screw adjustment is provided for changing governed speed. For convenience in paralleling, the speed droop can also be varied to greater than 3%.

COOLING SYSTEM—For most applications, the engine is equipped with a radiator cooling system and an impeller type jacket water pump. Large passages in the cylinder head insure efficient cooling of the combustion chamber, injection nozzle, valves, and exhaust passages. A thermostat and recirculating water connection provide automatic control of cooling water temperature. The jacket water pump and radiator fan are V-belt driven from the crankshaft, and a fan guard is provided for protection.

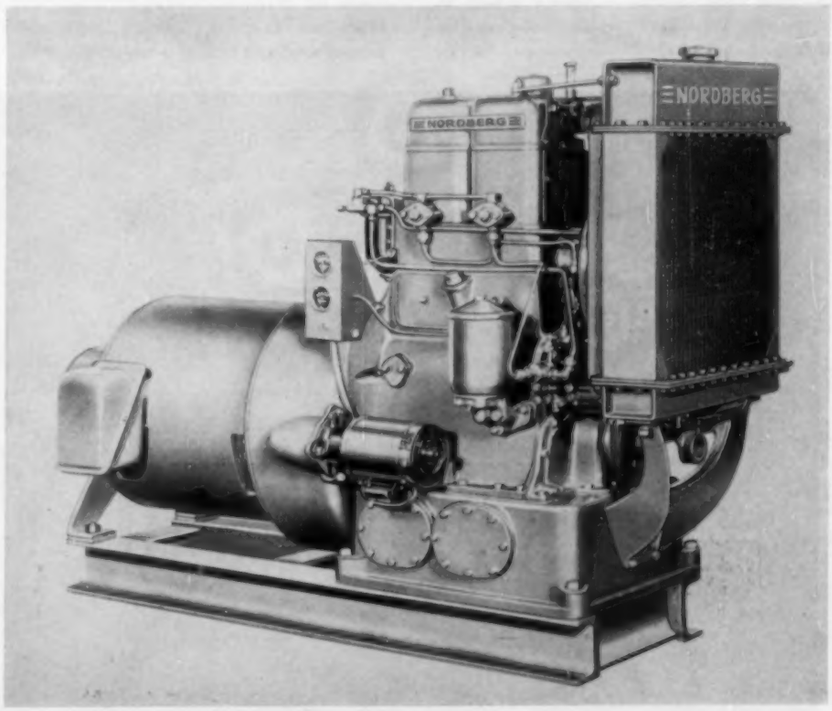
For marine applications, a heat exchanger cooling system is available as optional equipment. The heat exchanger cooling system includes jacket water pump and drive, raw water pump and drive, heat exchanger and expansion tank, all mounted on the engine. Thermostatic temperature control is provided, and engines equipped with this system need only connections for the raw water inlet and outlet—no other external piping or connections are required. Engine can also be furnished with jacket water pump and drive, thermostatic control valve and by-pass arrangement suitable for use with a keel cooler.

Starting Equipment

Diesel Engines—Twelve volt electric starting equipment is available on all engines. The high-torque starting motor is actuated by a push-button on the gauge board and controlled by a solenoid switch. The battery charging generator is V-belt driven from the crankshaft and is provided with voltage regulator and reverse current protection. All engines may be easily hand cranked, with a simple compression release provided to facilitate cranking. Generator sets can be optionally equipped to start automatically to provide stand-by power in the event of main power failure. The engine remains in operation until main power is restored, then stops automatically.

Gas Engines—Gas engines are hand cranked, with a compression release available as optional equipment. Electric starting motor or air starting motor can also be furnished if desired.

Nordberg Power Chief 4FS2-C2 Diesel with generating unit. In one, two and three cylinder models, these units generate 6 KW to 30 KW.



NORDBERG "POWER CHIEF" ENGINES

Number of Cylinders	Bore	Stroke	Diesel		Gas	
			R.P.M.	Continuous Horsepower	R.P.M.	Continuous Horsepower
1	4½"	5¼"	1200-1800	10-15	800-1800	8-18
2	4½"	5¼"	1200-1800	20-30	800-1800	16-36
3	4½"	5¼"	1200-1800	30-45		

ALLIS-CHALMERS
BUDA DIVISION

INDUSTRIAL, MARINE, OIL FIELD and GENERATOR SETS

THROUGH many years of designing and producing Diesel engines for the automotive and industrial fields, Allis-Chalmers, Buda Division has developed one of the most extensive lines of engines to fit countless application.

The Allis-Chalmers line is of the four cycle type with models ranging in size from two to eight cylinders having 9 to 516 horsepower. To give greater serviceable life and more power, the engines have incorporated into their design the "Follow Through" rise combustion system.

Many models are available as either turbocharged, supercharged or non-supercharged, giving a wide selection to choose from.

The basic design of all these engines is the same but variations are made as required to adapt the engines to various services. The service ratings also vary according to the application.

CRANKCASE AND CYLINDER block is a one piece alloyed iron casting designed to be the main structural member of the engine.

CYLINDER LINERS made of alloy cast iron, of the removable wet sleeve type, enter the cylinder block from the top.

MAIN BEARINGS are carried in the lower part of the crankcase casting, and are of the steel back, copper-lead precision type.

OIL PAN is secured to the bottom flange of the crankcase, except for certain application conditions in industrial work, a cast iron base is used which also serves as the oil pan; this base has foundation support flanges extending along the sides. Otherwise, the engine has supports at the ends.

CRANKSHAFT is drop forged open hearth steel, balanced statically and dynamically, with Tocco hardened ground and lapped journal surfaces.

CONNECTING RODS are drop forged alloy steel, heat treated, and carefully balanced in sets. Crankpin bearings are steel back copper-lead precision type. Piston pin is of full floating type.

PISTONS are aluminum alloy with an oil control ring above and below the piston pin.

CYLINDER HEADS are copper chrome, alloyed cast iron with replaceable exhaust valve seat inserts. Smaller cylinder engines have one piece heads for entire engine while larger sizes have heads cast in pairs. Cylinder head covers are pressed steel and readily detachable.

VALVES are operated by pushrods. Inlet valves are of chrome nickel steel; exhaust valves of austenitic steel.

CAMSHAFT with integral cams is of special alloy and ground for precision type bearings. Steel timing gears with helical teeth are used.

FUEL SYSTEM includes a plunger type fuel supply pump attached to the fuel injection pump which is controlled by its flyball governor; pintle type nozzles in the cylinder head; filters for assuring clean fuel.

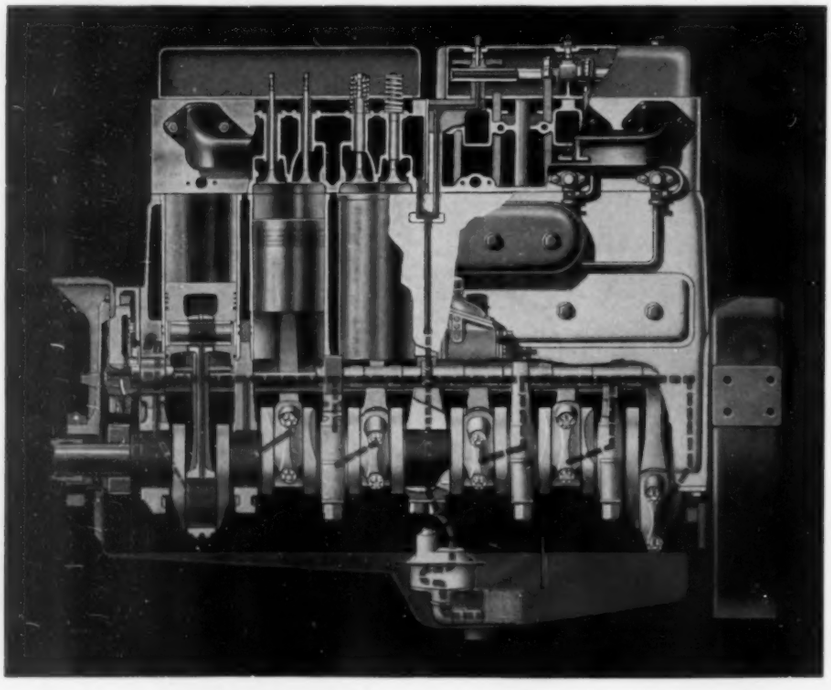
LUBRICATING SYSTEM cares for all bearings and other parts needing lubrication. Pumps are of the gear type and positively driven for pressure lubrication. Filters for assuring clean oil are provided. Oil temperature regulators can be supplied when required.

COOLING SYSTEM details vary according to the application of the engine, but all models are water cooled and an engine driven circulating pump is provided.

OIL BATH AIR CLEANERS can be supplied for applications with the cleanest to the dustiest air.

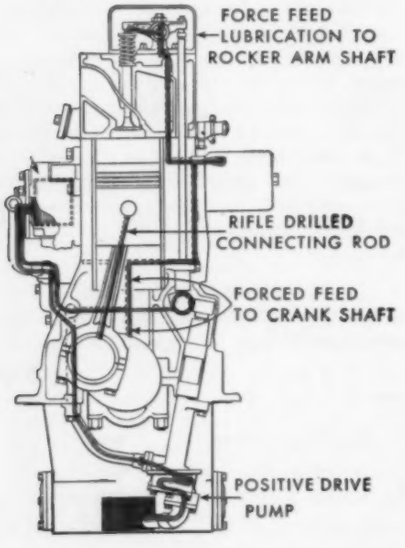
SUPERCHARGERS, when used, are of the positive displacement type with helical rotors for quietness.

STARTING methods of various types are available according to the size of the engine and drive of the customer. The smaller engines have 12 volt electric system with starting motor and generator mounted on the engine; the larger engines have 24 or 32 volt electric equipment or can be furnished with gasoline starting engine or an air starting motor.



Diagrammatic view of lubrication system of Allis-Chalmers "161" Series Diesels. Oil indicated in red. A positive feed oil pump located in a sump in the crankcase provides force feed circulation to main and connecting rod bearings, wrist pins, camshaft bearings and rollers, idler gear bearing and rocker arm shafts. Return line provides additional overflow lubrication of timing gears. Heat is dissipated by circulation through an amply sized oil temperature regulator. Oil pressure is regulated by a spring loaded piston valve, adjustable from outside of engine with a regulating screw.

A line drawing of transverse section "161" series Diesels indicating path of lubrication.

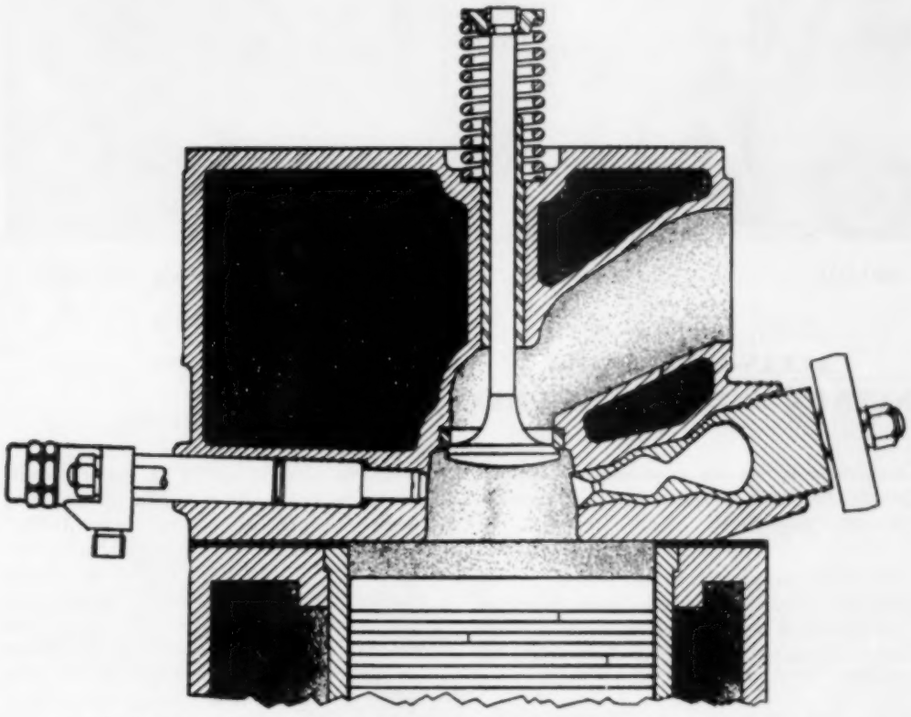


ALLIS-CHALMERS "FOLLOW THROUGH" CONTROLLED COMBUSTION MORE POWER – LESS WASTED FUEL

All of the Allis-Chalmers Diesel engines manufactured by the Buda Division have incorporated into their design the "follow through" combustion system. This advanced engineering feature results in more power, less fuel consumption and smoother operation with less vibration; in addition, engines will last longer . . . produce more . . . with lower operating costs and maintenance giving greater service for a wide range of installations.

The low rate of pressure rise (as shown in the comparison chart below), low peak pressures and completely controlled turbulence are some of the reasons why Allis-Chalmers Diesels provide quiet operation at all speeds and also why they provide more power with far less strain on operating parts.

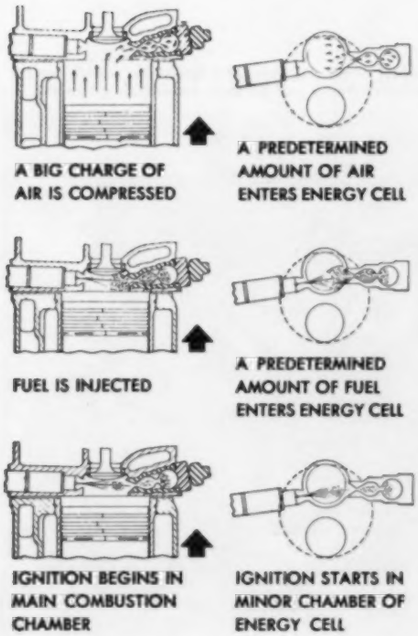
It is common knowledge that some of the principal difficulties in satisfactory operation of a Diesel have been due to extremely high sudden shocking pressures that develop in the cylinder chambers producing devastating effects on pistons, rods, bearings and all working parts. These difficulties have never been present in the Allis-Chalmers 4 cycle Diesels. Numerous superior advantages are incorporated in our combustion system. Of these, the four most important are: (1) Lower peak pressures in the cylinders; (2) a low rate of pressure rise due to well-controlled "follow through" combustion; (3) due to vigorous controlled turbulence there results a complete combustion with low fuel consumption and no wasted fuel in the form of heavy black exhaust; and (4) lower peak cylinder temperatures which are easier on lubricating oil, results in complete lubrication of cylinder walls and longer piston and ring life.



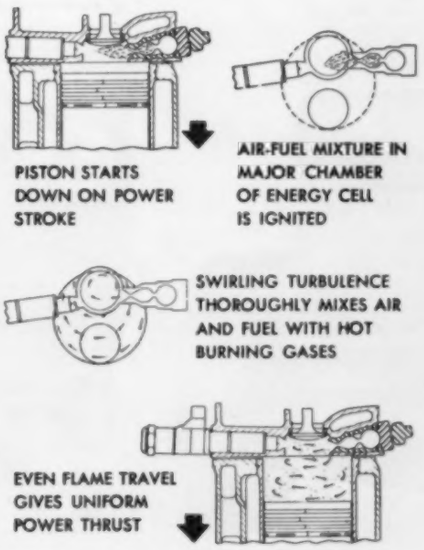
Vertical cross-section of the Allis-Chalmers Diesel cylinder and cylinder head showing the location of the basic parts of the Allis-Chalmers "Follow Through" controlled combustion system.

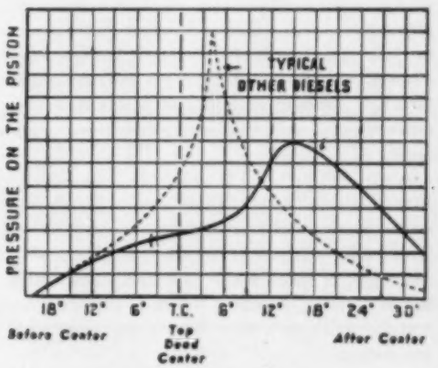
HOW IT WORKS

COMPRESSION CYCLE


A BIG CHARGE OF AIR IS COMPRESSED
A PREDETERMINED AMOUNT OF AIR ENTERS ENERGY CELL
FUEL IS INJECTED
A PREDETERMINED AMOUNT OF FUEL ENTERS ENERGY CELL
IGNITION BEGINS IN MAIN COMBUSTION CHAMBER
IGNITION STARTS IN MINOR CHAMBER OF ENERGY CELL

POWER CYCLE


PISTON STARTS DOWN ON POWER STROKE
AIR-FUEL MIXTURE IN MAJOR CHAMBER OF ENERGY CELL IS IGNITED
SWIRLING TURBULENCE THOROUGHLY MIXES AIR AND FUEL WITH HOT BURNING GASES
EVEN FLAME TRAVEL GIVES UNIFORM POWER THRUST

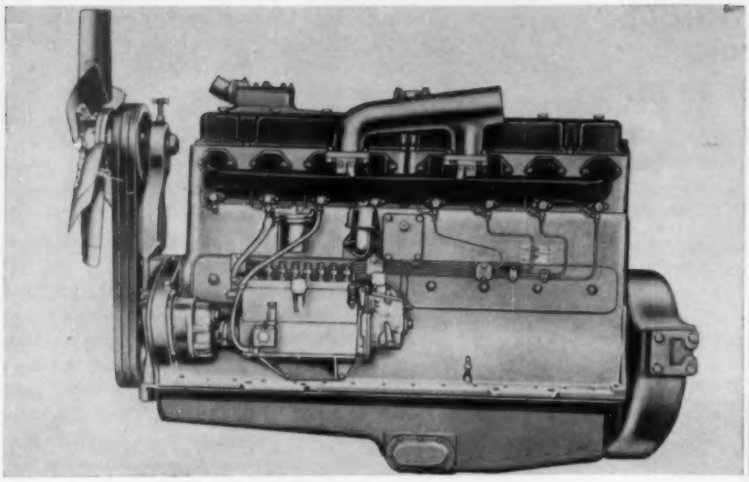


"LOW PRESSURE RISE" CONTROLLED COMBUSTION

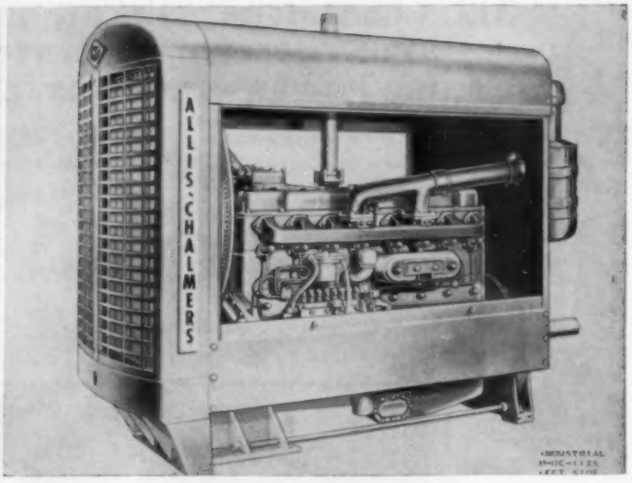
Anyone can appreciate the difference between hitting a piston with a sledge hammer at the time when the piston is at top center, or giving it a strong steady push. The former is, in effect about what happens in an ordinary Diesel . . . and the latter in an Allis-Chalmers "Low Pressure Rise" Diesel. This low pressure rise and prolonged "soft" combustion compares with the steady push in a steam engine.

(Above) Allis-Chalmers Diesel "Low Pressure Rise" Combustion.

(Below) "Fast-High Pressure Shock" in ordinary Diesels.



Diesel fan to flywheel engine Model 8DA-1125.



Typical Buda "161" Series Diesel Power Unit—8 cylinder model 8DA-1125 Diesel engine.

ALLIS-CHALMERS ENGINES AND POWER UNITS

Allis-Chalmers Diesel Engines are designed and built for heavy-duty continuous service. Outstanding savings in operating costs are being enjoyed by the large number of users of Allis-Chalmers engines. They are specified as standard Diesel power by many manufacturers of shovels, cranes, locomotives, compressors, feed mills, hammer mills, drill rigs, pumping units, rollers, pavers and many other types of industrial and construction equipment.

Allis-Chalmers Diesel engines meet variable and severe load conditions—with a smooth flow of power from no load to full load. High torque is developed at speed lower than normal operating R.P.M., giving excellent starting characteristics and the ability to handle "drag down" loads without stalling.

Fuel Pump and nozzles are of simple design and sturdy construction. Nozzles can be removed as readily as spark plugs.

Solid fuel injection; that is, fuel pumped directly into the combustion chambers without the use of compressed air or pre-combustion chambers. There are no hot spots, hot surfaces or electrical ignition devices.

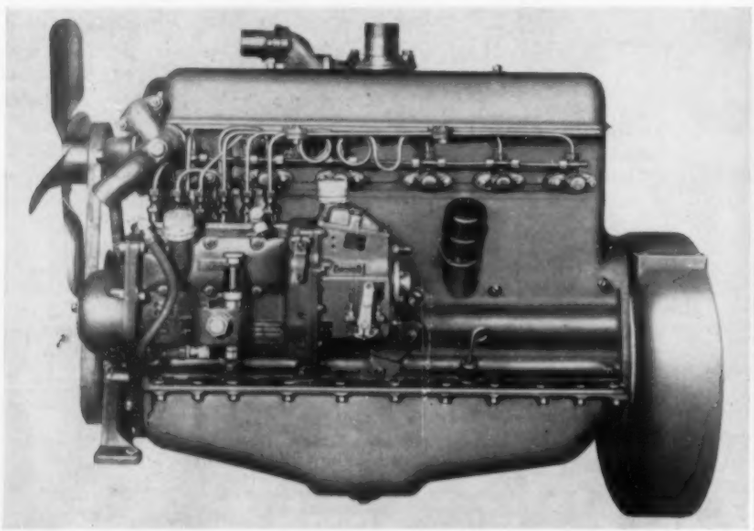
High thermal efficiency, due to complete scavenging afforded by four-stroke-cycle design.

Starts quickly from cold by means of electric starter.

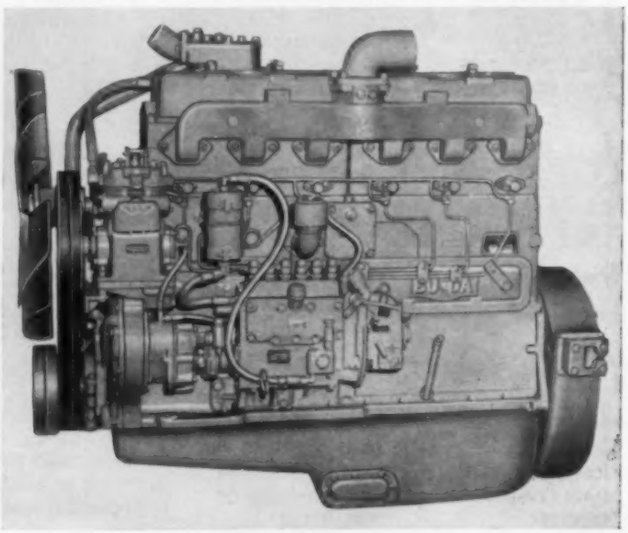
In the Allis-Chalmers line of Diesel engines, interchangeable parts is one of the main features eliminating the need for vast stocks of fast wearing parts to facilitate each particular model. Divided into three series, the main distinction between the engines in each series is the number of cylinders and length: the series of smaller engines consists of 5 models having two, four and six cylinders with the range of 9 to 90 maximum horsepower; next in size is the extremely popular 161 series consisting of 7 models of six and eight cylinder engines ranging from 80 to 350 maximum horsepower; the larger series includes 4 models of six and eight cylinders having a range from 192 to 516 maximum horsepower.

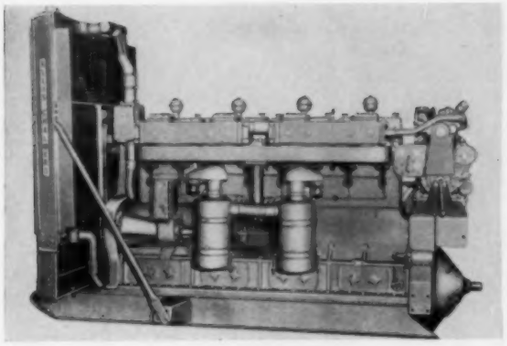
Available with air or electric starting on all models and gasoline starting engines on those models of 779 cu. in. displacement and greater.

Six cylinder fan to flywheel type Model 6DA-230 Diesel engine.

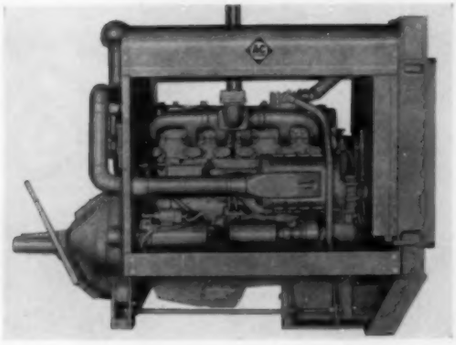


Model 6DA-844 fan to flywheel Diesel Engine—This Diesel has a wide variety of applications for heavy duty trucks and portable industrial equipment.





Model 8DC-2505 eight cylinder Diesel engine.



Right Side of Buda Model 6DAS-844 Industrial type supercharged power unit. The supercharger is gear driven from the timing gear case.

DIESEL ENGINE HORSEPOWER CHART AND CONDENSED SPECIFICATIONS

Model	Bore & Stroke	Displacement Cubic Inch	Max. Torque @ R.P.M.	Service	Curve	HORSEPOWER AT VARIOUS SPEEDS 600	800	1000	1200	1300	1400	1600	1800	2000	2100
2 Cylinder 2BD-77	3½ x 4½	77	49 @ 1400	Bare Engine	A			9	11	12	13	14.5	16	17	
					B			8	10.5	11	12	13.5	15		
					C			7	9	10	11	12.5	13.5		
			45 @ 1400	Power Unit	A			8.5	10.5	11.5	12	13.5	14		
					B			7.5	9.5	10.5	11	12.5	12.5		
					C			6.5	8.5	9	10	11	11		
4 Cylinder 4DA-153	3½ x 4½	153	111 @ 1250	Bare Engine	A		16	21	26	28	30	33	35	37	
					B		14	18.5	23	25	27	30	32	33	
					C		12.5	17.5	21	22.5	24	27	28	29	
			100 @ 1000	Power Unit	A		15.5	19	22.5	24.5	26	29	31.5	33	
					B		13.5	16.5	20	22	23.5	26	28	29	
					C		12.5	15	18.5	19.5	21.5	23	25	25.5	
4 Cylinder 4DA-183	3¼ x 4½	183	138 @ 1500	Bare Engine	A			25	31	34	37	42	46	49	
					B			23	28	31	33	38	42	44	
					C			20	25	27	29	33	37	39	
			127 @ 1400	Power Unit	A			23.5	28.5	31.5	34	39	42.5	44	
					B			21	25.5	27.5	30	34	37	39	
					C			19	22.5	25	26	30	32.5	34	
6 Cylinder 6DA-230	3½ x 4½	230	166 @ 1250	Bare Engine	A		24	32	38	41	44	49	53	56	
					B		21	28	35	38	41	45	48	50	
					C		19	26	32	34	36	41	43	45	
			138 @ 1200	Power Unit	A		22.5	29	35	38	41	45	48	50	
					B		20	26	32.5	35	37	41	44	45	
					C		18.5	24	28	31	33	36.5	39	40	
6 Cylinder 6DA-273	3¼ x 4½	273	204 @ 1400	Bare Engine	A			38	46	50	54	62	69	74	
					B			34	41	45	48	55	61	66	
					C			30	36	39	43	48	54	58	
			192 @ 1200	Power Unit	A			33.5	44	47.5	51	57.5	63	66	
					B			32.5	39	42	45	51	58	58	
					C			28	34	35.5	39	44	48	50	
6 Cylinder 6DT-317	3⅝ x 5½	317	222 @ 1400	Bare Engine	A		30	40.5	50	55	59.5	68	76	82	85
					B		28	35	44	47	52	59	66	73	75
					C		22.5	30	39	42	45	52	56		
				Power Unit	A										
					B										
					C										
6 Cylinder 6DA-779	5¼ x 6	779	560 @ 1300	Bare Engine	A		81	105	129	140	150	167	179	185	187
					B		73	95	116	126	135	151	162	168	169
					C		62	84	112	113	120	133	142		
			530 @ 1200	Power Unit	A		79	100	120	130	140	153.5	139		
					B		71	90	109	118	125	138	143		
					C		61	81	98.5	105	110	119	123		
6 Cylinder 6DA-844	5¼ x 6½	844	650 @ 1300	Bare Engine	A		93	121	149	161	173	193	208	214	215
					B		81	108	132	144	156	173	187	194	195
					C		74	98	120	130	140	156	166		
			625 @ 1200	Power Unit	A		90	119	141	154	163	179	188		
					B		79	100	125	135	145	159	168		
					C		70	93	115	123	130	141	147		
6 Cylinder 6DAS-844	5¼ x 6½	844	780 @ 1500	Bare Engine	A		100	137	172	190	207	238	262	278	280
					B		89	122	157	171	187	213	239	247	
					C		75	109	130	142	155	178	196		
			740 @ 1400	Power Unit	A		99	113	163	182	193	225	243		
					B		89	120	150	164	177	199	213		
					C		74	99	124	135	143	165	178		
6 Cylinder 6DA-970	5¾ x 6½	970	732 @ 1200	Bare Engine	A		110	142	172	185	198	220	233	240	240
					B		96	123	150	164	176	197	212	215	
					C		84	110	136	147	159	178	188		
			710 @ 1200	Power Unit	A		105	132	160	172	183	200	213		
					B		93	117	140	150	160	176	187		
					C		80	104	124	134	143	157	163		
8 Cylinder 8DA-1125	5¼ x 6½	1125	830 @ 1300	Bare Engine	A		109	145	180	199	215	242	269	284	287
					B		95	134	166	182	195	220	239	232	
					C		85	125	155	170	183	208	223		
			740 @ 1250	Power Unit	A		114	134	165	180	196	220	239		
					B		92	123	157	169	180	200	210		
					C		84	117	145	158	169	187	198		
8 Cylinder 8DAS-1125	5¼ x 6½	1125	970 @ 1400	Bare Engine	A		127	172	213	235	255	290	320	344	330
					B		115	134	194	212	230	260	283	303	
					C		98	130	164	180	195	221	242		
			900 @ 1250	Power Unit	A		124	161	200	220	237	265	289		
					B		116	146	180	197	210	236	254		
					C		85	98	148	161	174	195	208		
8 Cylinder 8DC-1290	5¾ x 6½	1290	960 @ 1100	Bare Engine	A		138	180	217	232	245	261	268		
					B		128	165	197	212	222	237	244		
					C		110	140	170	180	190	204	209		
				Power Unit	A										
					B										
					C										
6 Cylinder 6DCB-1879	6½x8¼	1879	1400 @ 850	Bare Engine	A	143	211	259	281	282					
					B	132	195	241	262						
					C	118	175	217	236						
			1300 @ 800	Power Unit	A	135	199	238	230						
					B	123	180	219	232						
					C	109	160	198	208						
6 Cylinder 6DCS-1879	6½ x 8¼	1879	1570 @ 650	Bare Engine	A	182	238	291	330	340					
					B	153	212	257	290						
					C	145	190	232	264						
			1500 @ 600	Power Unit	A	170	224	268	295						
					B	149	193	211	250						
					C	138	175	208	228						
8 Cylinder 8DC-2505	6¼ x 8¼	2505	1910 @ 850	Bare Engine	A	200	290	354	385	390					
					B	176	266	328	350						
					C	160	234	284	309						
			1790 @ 850	Power Unit	A	190	275	330	345						
					B	165	245	300	312						
					C	150	215	258	265						
8 Cylinder 8DCS-2505	6¼ x 8¼	2505	2390 @ 850	Bare Engine	A	260	364	448	506	516					
					B	234	318	395	447						
					C	209	290	360	400						
			2220 @ 850	Power Unit	A	247	340	415	463						
					B	217	290	365	395						
					C	195	280	320	330						

"A" MAXIMUM LABORATORY PERFORMANCE—The maximum power the bare engine will develop for five minutes without loss in speed.

"B" INTERMITTENT DUTY—The power available for applications having varying loads and speeds with full power being required for short periods.

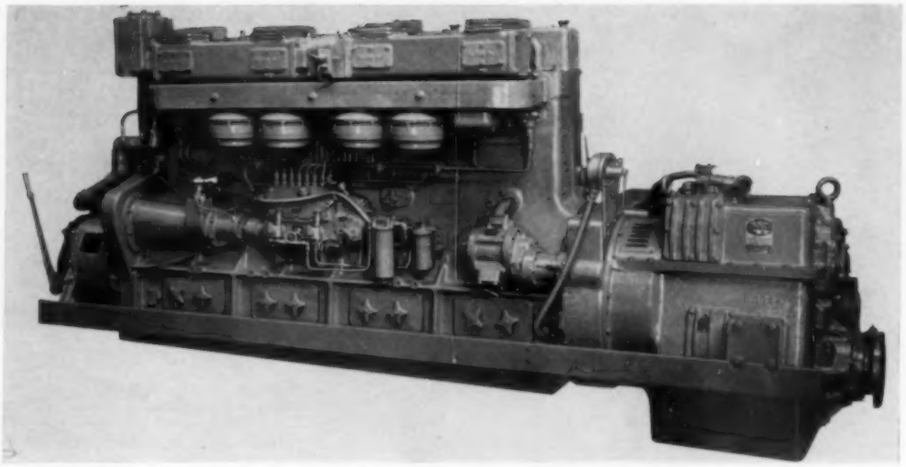
"C" CONTINUOUS DUTY—The power available for driving sustained full loads for 24 hours per day operation.

ALTITUDE AND TEMPERATURE RATINGS

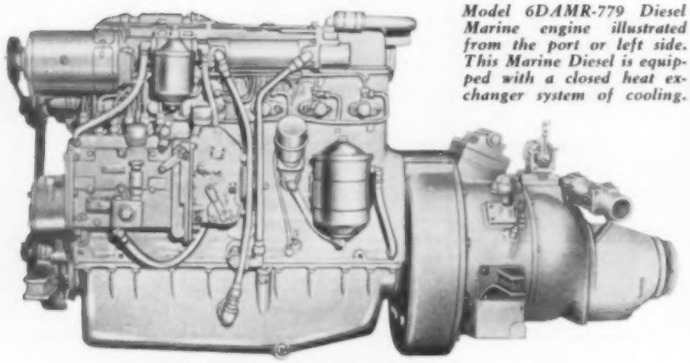
For approximate ratings deduct from the intermittent or continuous rating; 3 percent per 1,000 feet above 1,000 feet altitude and 1 percent per 10 degrees above 60 degrees F.

ALLIS-CHALMERS MARINE ENGINE POWER

The Allis-Chalmers Buda Division manufactures one of the most outstanding line of Diesel marine engines in the field, ranging from 15 to 516 h.p. This line of engines incorporates all of the outstanding features of the Allis-Chalmers heavy-duty Diesels as well as special designs for light weight high speed engines for use in pleasure craft and offshore transportation boats. Larger piston displacement, quieter operation, less vibration, long life and operating economy are all important features incorporated in the basic design.

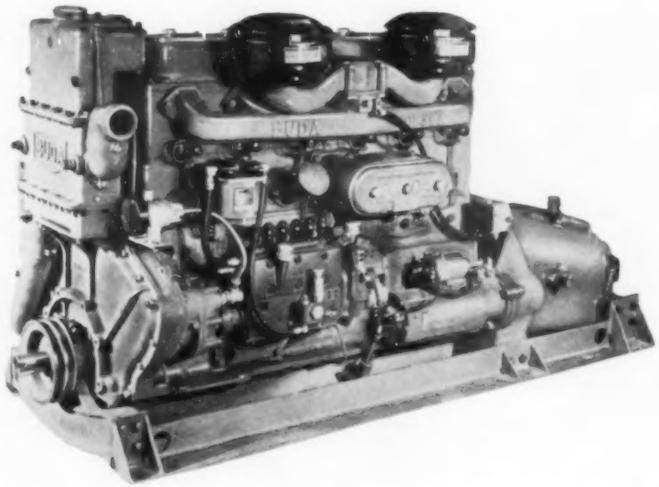


Model 8DCMR-2505 eight cylinder Diesel which develops a maximum of 388 horsepower at 1300 rpm.



Model 6DAMR-273 with Hydraulic Reverse and Reduction Gear.

Model 6DAMR-779 Diesel Marine engine illustrated from the port or left side. This Marine Diesel is equipped with a closed heat exchanger system of cooling.



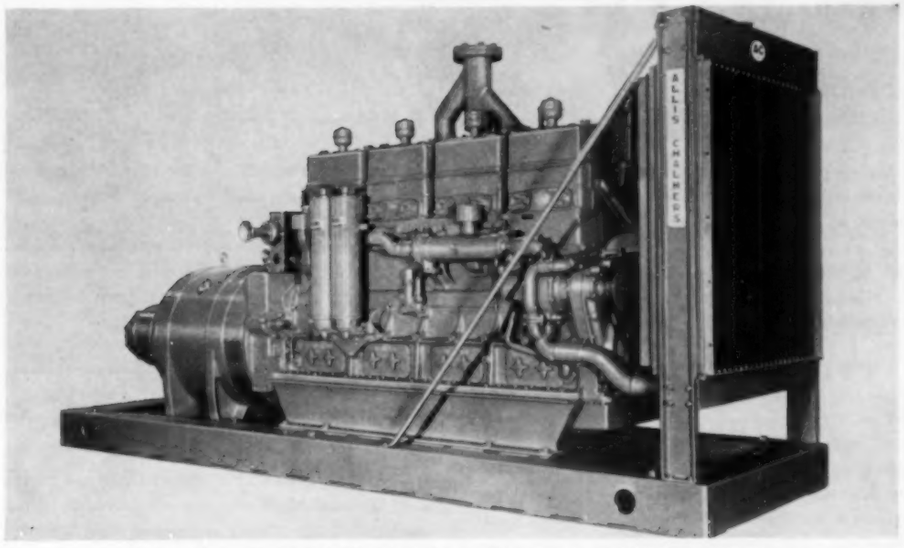
Latest additions to the line include the 85 shaft horsepower model 6DAMR-273, weighing less than 1000 pounds, for use in pleasure, fish and small work boats as well as turbocharged model 8DATMR-1125 developing 300 shaft horsepower @ 1900 R.P.M. with a net weight of 4400 pounds which has been field tested and proven successful in towboats, fish boats and high speed crew boats.

Choice of equipment includes: air or electric starting; heat exchanger or keel cooling; hydraulic air and mechanical operated reverse and reduction gears; by-pass and full flow lube oil filters; electric or mechanical instrument panel; hourmeter; high water temperature and low lube oil pressure automatic alarm; overspeed alarm or shutdown; aluminum or cast iron construction; A.B.S.—Lloyds—Bureau Veritas and Canadian Dept. Transport approval.

ALLIS-CHALMERS MARINE DIESELS

Model	Bore & Stroke	Cu. in. Displ.	No. of Cylinders	Rated HP @ RPM	Overall Dimensions*			Weight (lbs.)
					Length (A)	Width (B)	Height (C)	
6DAMR-273	3¾ x 4⅛	273	6	85 @ 2800	55⅛	26	29 3/32	879
6DAMR-779	5¼ x 6	779	6	185 @ 2100	76 3/8	32 1/16	42 1/8	3,325
6DAMR-844	5¼ x 6½	844	6	215 @ 2000	76 1/8	32 1/16	42 1/8	3,375
6DASMR-844 (Supercharged)	5¼ x 6½	844	6	275 @ 2000	77 5/32	33 3/16	46⅝	4,065
8DAMR-1125	5¼ x 6½	1125	8	285 @ 2000	100⅛	34½	45⅛	4,265
8DATMR-1125 (Turbocharged)	5¼ x 6½	1125	8	385 @ 2000	97¼	32½	56⅛	4,400
6DCBMR-1879	6¾ x 8¾	1879	6	262 @ 1300	108¼	37	62⅛	9,830
8DCMR-2505	6¾ x 8¾	2505	8	388 @ 1300	141 1/16	42 1/16	64½	11,800
8DCSMR-2505 (Supercharged)	6¾ x 8¾	2505	8	516 @ 1300	159¼	50¼	65¾	14,330

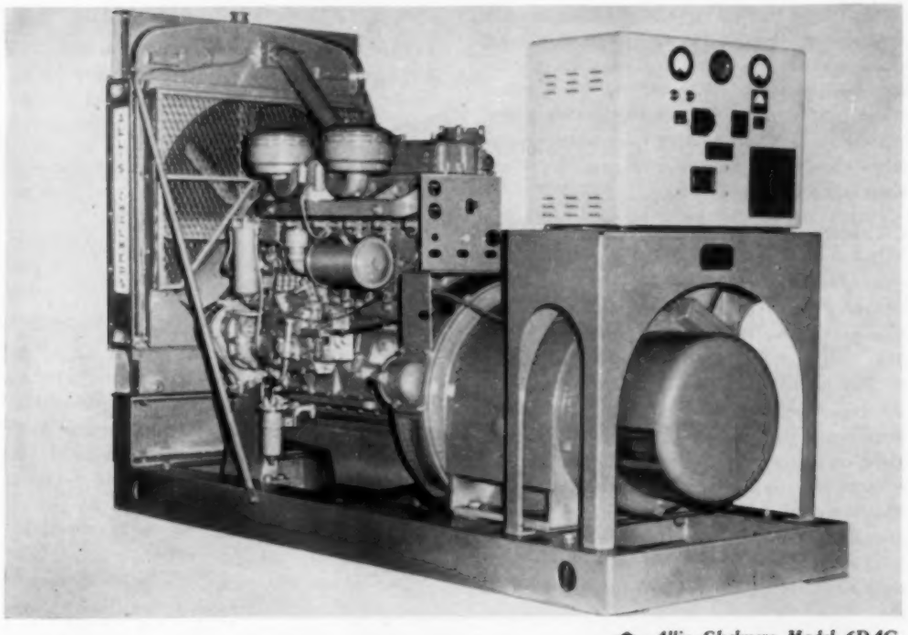
ALLIS-CHALMERS DIESEL GENERATOR SETS



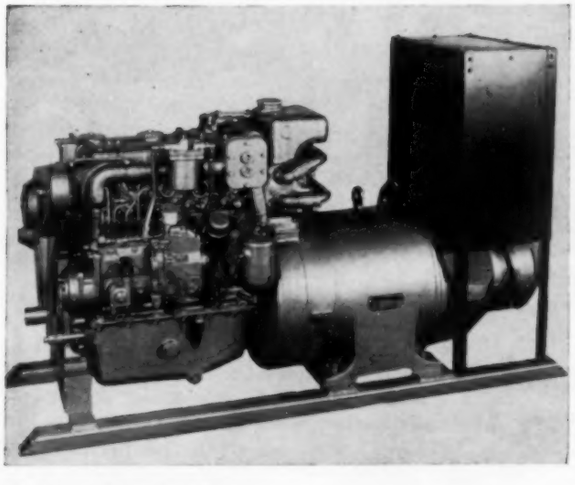
Allis-Chalmers Model 8DCSG-2505 eight cylinder supercharged diesel generator set.

Allis-Chalmers Engine Electric Generator Sets are complete, compact, reliable sources of electric power suitable for all types of jobs whether emergency or continuous duty power service. They are available in a wide variety of basic models in sizes from 5 to 300 KW capacities. These generator sets can be supplied alternating current, single or three phase, fifty or sixty cycles in a wide range of standard voltages to meet your power and light requirements.

A selection of accessories is offered in cooling systems, safety controls, electrical controls and engine accessory features for successful application of these generator sets to a wide variety of installation requirements.



Allis-Chalmers Model 6DAG-779 six cylinder Diesel electric generator set.



Four cylinder heat exchanger cooled Marine Diesel electric generator set.

Diesel-Electric Generator Sets

Gen. Set Model*	Engine	R.P.M.	K.W. Rated	K.W. Cont.	Cycles	Approx. Weight (lbs.) Including Radiator & Switchboard
5D-5A	2BDG-77	1200	5	5	60	1100
5DA-5A	2BDG-77	1800	7½	7½	60	1100
5D-6	2BDG-77	1500	6	6		1100
5D-6A	2BDG-77	1500	7	6	50	1100
DA-11A	4DA-153	1200	11	10	60	1240
DA-11A3	4DA-153	1200	11	10	60	1240
DAA-15A	4DA-153	1800	16	15	60	1240
DAA-15A3	4DA-153	1800	16	15	60	1240
DA-14A	4DA-153	1500	14	13	50	1230
DA-14A3	4DA-153	1500	14	13	50	1230
DA-16A	6DA-230	1200	16	15	60	1330
DA-16A3	6DA-230	1200	16	15	60	1330
DAA-27A	6DA-230	1800	27	25	60	1340
DAA-27A3	6DA-230	1800	27	25	60	1340
DA-22A	6DA-230	1500	22	20	50	1330
DA-22A3	6DA-230	1500	22	20	50	1330
DAA-33A3	6DAG-273	1800	33	30	60	1330
DT-25A	6DTG-317	1200	25	23	60	3080
DT-25A3	6DTG-317	1200	25	23	60	3080
DTA-38A	6DTG-317	1800	38	35	60	3080
DTA-38A3	6DTG-317	1800	38	35	60	3080
DT-21A	6DTG-317	1000	21	20	50	3100
DT-21A3	6DTG-317	1000	21	20	50	3100
DTA-31A	6DTG-317	1500	31	29	50	3100
DTA-31A3	6DTG-317	1500	31	29	50	3100
DA-66A3	6DAG-779	1200	66	60	60	5325
DAA-82A3	6DAG-779	1800	82	75	60	5325
DA-55A3	6DAG-779	1000	55	50	50	5325
DAA-81A3	6DAG-779	1500	81	73	50	6250
DA-82A3	6DAG-970	1200	82	75	60	5550
DAA-110A3	6DAG-970	1800	110	100	60	5800
DAA-125A3	6DAG-970	1800	125	100	60	5930
DA-68A3	6DAG-970	1000	68	62	50	6150
DAA-104A3	6DAG-970	1500	104	94	50	6250
DAA-150A3	8DAG-1125	1800	150	130	60	8100
DC-110A3	8DCG-1290	1200	110	100	60	7795
DC-90A3	8DCG-1290	1000	90	83	50	7850
DCA-137A3	8DCG-1290	1500	137	123	50	7900
DCB-110A3	6DCBG-1879	720	110	100	60	12430
DCB-138A3	6DCBG-1879	900	138	125	60	12750
DCBA-165A3	6DCBG-1879	1200	165	150	60	12750
DCB-109A3	6DCBG-1879	750	109	100	50	12430
DCBA-137A3	6DCBG-1879	1000	137	125	50	12500
DCS-128A3	6DCSG-1879	750	128	118	50	13000
DCSA-165A3	6DCSG-1879	1000	165	150	50	13050
DC-137A3	8DCG-2505	720	137	125	60	13600
DC-165A3	8DCG-2505	900	165	150	60	13600
DCA-220A3	8DCG-2505	1200	220	200	60	13600
DC-135A3	8DCG-2505	750	153	140	50	17400
DCA-200A3	8DCG-2505	1000	200	175	50	17450
DCS-190A3	8DCSG-2505	720	190	170	60	16300
DCS-220A3	8DCSG-2505	900	220	200	60	16300
DCSA-275A3	8DCSG-2505	1200	275	250	60	16300
DCSA-300A3	8DCSG-2505	1200	*	300	60	16700
DCS-192A3	8DCSG-2505	750	192	175	50	18100
DCSA-265A3	8DCSG-2505	1000	265	235	50	18150

* If intermittent overloads are required, consult the factory for recommendations.

CHICAGO PNEUMATIC

CHICAGO Pneumatic Diesel engines are heavy-duty, medium-speed machines of the four-cycle, direct injection, totally enclosed type designed for the arduous duties of stationary service but widely adaptable to other uses and to a wide variety of installation and operating conditions. Built in several cylinder sizes and in from three to eight cylinders per unit, with many of the models turbocharged, there is a range of from 90 to 2280 horsepower at normal ratings for continuous service.

All of the engines have the usual 10 per cent overload capacity, and some will operate at higher speeds with corresponding increases of power for intermittent periods. There are four basic models and each will be discussed separately.

All Chicago Pneumatic engines can burn gas fuel by converting them into Otto cycle gas engines or into dual-fuel engines. Conversion parts are available and a minimum number are required.

TYPES 8-CP AND 9-CP

These types have cylinders 8 or 9 by 10½ inches and the normal ratings are 37½ and 48½ horsepower per cylinder at 720 rpm. Intermittently, the type 8-CP can be operated up to 900 rpm. They are built in three, four, six and eight cylinder units. There is a normal power range of from 90 to 385 horsepower, or 60 to 250 kw. at 600/720 rpm for normal aspiration. Turbocharged units provide up to 400 kw. at 720 rpm.

The general appearance of these engines is seen from the illustrations of the six-cylinder unit here, and the sectional views bring out the details of the design.

BASE of cast iron alloy is suitable for marine and other services as well as for stationary work. The engine can be supported on the foundation either by the heavy flange construction along the sides, as in marine installations, or by the grouting under wide ledge of the base on the concrete block foundation of a stationary job. Deep trough of base provides large lubricating oil sump. Lube oil distribution supply header to main bearings is a pipe cast into the lower part of base as shown. Substantial cross girders provide for main bearing supports. Top of base is machined to support the frame.

FRAME of cast iron alloy has broad flanges and surfaces for resting on the base. For structural strength and rigidity, frame and base are held together by suitably located tie bolts which extend to the top of the frame. In addition, there is a row of bolts along each side of the engine at the outside. These bolts take some mechanical load and insure a tight oil joint between base and frame. Frame casting has large openings on each side for access to the crankcase space, provides for water jackets for the cylinder liners, includes the enclosure along the front for the camshaft, fuel injection pumps, and valve gear, and gives support for some of the accessories on the outside.

CYLINDER LINERS are Nickel Chromium cast iron. They are supported in the frame by the flanges at the top, where a rabbet fit centers the cylinder head and provides a seat for the head gasket. Water jackets extend the full length of the liners, and the usual rubber packing rings seal the water joints thus permitting liner expansion at the lower end.

CYLINDER HEADS are individual High Grade Nickel iron castings of general rectangular shape in order to extend out to the outside lines of the frame and carry the same lines upward, and at the same time provide for the enclosure of the valve gear push rods and for connections to the inlet and exhaust headers, the former along the front of the engine and the latter at the back. In effect, these heads give an almost continuous structure along on top of the frame. To the top of each cylinder head is fastened a stamped steel cover, which covers the entire head and encloses the valve gear and the tops of the valves. Two hand tightened nuts hold these covers in place and make tight oil joints on the gaskets under the edges of the covers. These covers also serve to finish off the appearance of the top of the engine.

CRANKSHAFT is made from steel forging and is generously proportioned. End is flanged to take the flywheel.

MAIN AND CRANKPIN BEARINGS are precision Micro Babbitt which are replaceable without hand fitting. Thrust and center main bearings are extra long. Crankshaft is rifle drilled to carry oil from the main bearings to the crankpin bearings.

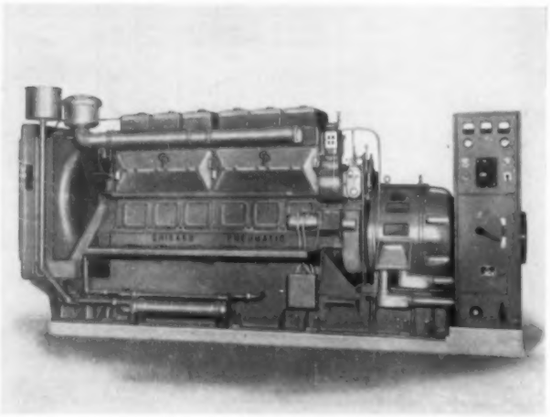
CONNECTING RODS are made from steel drop forgings with I-section bodies rifle drilled for oil to the wrist pin bearings. Upper ends of rods are fitted with bronze wrist pin bushings.

PISTONS are high tensile cast iron with the combustion chamber formed in the top, and have division plates for keeping oil from the under side of the piston crown. There are two oil control rings in addition to the compression rings. Wrist pins are steel, hardened and ground, of the full floating type.

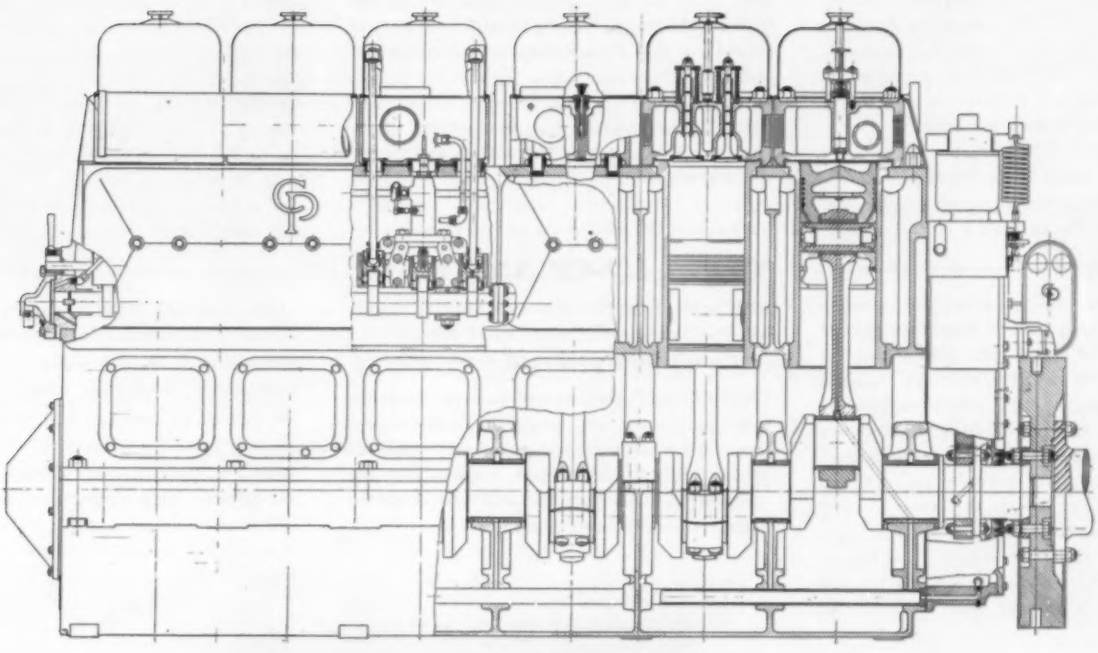
VALVES, inlet and exhaust, are carried in the cylinder head without cages but seat inserts for both are used. Valve stem guides are pressed into the heads. Exhaust valve is smaller than inlet valve in order to give maximum possible size to latter with the resultant good filling of the cylinder with air during the suction stroke. Air starting check valves seat directly in the head and are located toward the front; construction can be seen in section in the third cylinder from the right in the longitudinal sectional view. Inlet and exhaust valves are operated by rockers which are carried by a bracket bolted to the top of the cylinder head, and push rods.

CAMSHAFT is forged steel with cams integral; cam surfaces are hardened and contours accurately ground. Camshaft bearings and guides for the lower ends of valve gear push rods are combined in brackets bolted to the side of the frame inside of the enclosed space. Driving gear on the crankshaft for the gear train to the camshaft is split and bolted to the flange on the shaft; it is shown at the right in the longitudinal section adjacent to the flywheel.

FUEL INJECTION is by American Bosch or Bendix-Scintilla. An individual pump for each cylinder is located in the enclosure along the front of the frame, on the centerline of the cylinder, and operated by the camshaft. Fuel for all pumps is supplied through a filter, and from a header



Type 9-CP 6 Cylinder, Normally Aspirated Chicago Pneumatic 300 HP Package Type Diesel Engine.



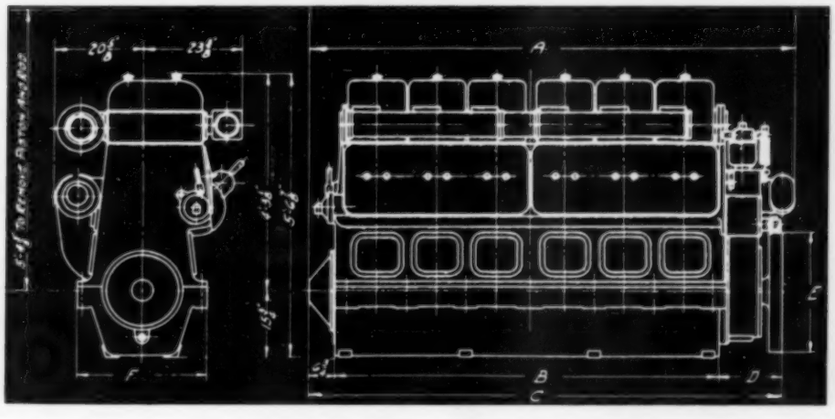
Longitudinal section of the Type 9-CP

running along the engine inside of the enclosure in front of the pumps. Discharge leads from the top of the pump through a short piece of tubing to the differential area spring loaded needle valve in the center of the cylinder head. Multihole spray nozzle tip is used, and the flattened Mexican hat shaped combustion chamber closely conforms to the shape of the jets to get the greatest volume of air where there is the greatest volume of fuel. Rim around the outside of the piston protects the cylinder wall from the direct blast of the jets, and by closely approaching the under side of the cylinder head at the top position of the piston stroke, gives desirable turbulence in the combustion chamber.

Fuel injection quantities are controlled by connecting the fuel pump racks with the common control shaft which can be seen running along just back of the fuel pumps near their tops. Slight rotation of this shaft by the governor provides full control. Governor is located at control station at flywheel end of engine, and is driven from the camshaft driving gear train. A Pickering, Woodward or Massey governor is used and the type varies according to the requirements of the installation.

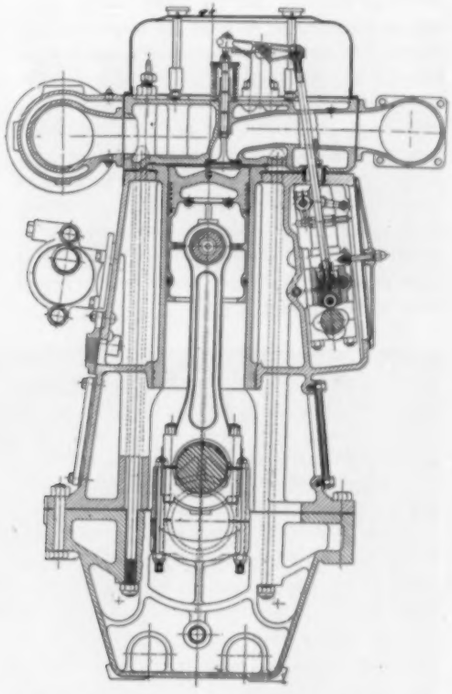
LUBRICATION is by pressure feed from attached rotary lube oil pump taking its suction from the sump and sending the oil through the filter and cooler back to the engine header in the base. Pipes lead oil to valve gear parts, so all bearings and parts are cared for by the single system. Upper wiper ring on the piston drains some of the oil it scrapes from the walls down to lubricate the wrist pin bearings.

Outline drawing of Chicago Pneumatic 8-CP & 9-CP Diesels



CHICAGO PNEUMATIC 8-CP & 9-CP DIESELS
Dimension (inches)

Key to Dimension	No. of Cylinders				Key to Dimension	No. of Cylinders			
	Three	Four	Six	Eight		Three	Four	Six	Eight
A	70⅛	86⅛	114⅛	142⅛	D	16⅛	16⅛	14⅝	14⅝
B	46⅛	62⅛	90⅛	118⅛	E	36	29	29	29
C	67½	83½	111½	139½	F	25½	30½	30⅛	32½



Cross-sectional drawing of the Chicago Pneumatic Diesel Type 9-CP.

COOLING WATER is usually supplied from an outside source, but provision is made for attaching a pump right to the engine when it is required. All cylinder jacket spaces are cross connected at the top, and all water is collected in the exhaust header jacket whence it flows overboard.

STARTING air valves in the cylinder head are timed from the distributor at the end of the cam shaft. Pipes from the distributor to the cylinder head valves are led inside the enclosure on the front of the frame. Starting control is at control station. Air and Electric starting motors are also available.

CONTROL STATION is at flywheel end of engine where all controls, instruments and gauges are concentrated.

TURBOCHARGING of the six and eight cylinder units is by Elliott system. Turbocharger is mounted at flywheel end so that overall dimensions of unit are only slightly increased.

COMPACTNESS is a feature of these types. Placing of the bedplate supporting flanges just below the level of the crankshaft keeps the upper parts of the engine within easy reach of the floor, and the intermediate parts such as the valve gear and fuel injection pumps at a convenient height.

TYPES 112-CP AND 114-CP

The Chicago Pneumatic type 112-CP has cylinders 11 by 12 inches. It is built in four, five, six and eight cylinders, and at 720 rpm. gives a range of from 332 to 1000 horsepower, normally aspirated and turbocharged. The type 114-CP engines are built in the same numbers of cylinders which are 11 by 14¼ inches and at 600 rpm. provide a range of 330 to 980 horsepower, normally aspirated and Turbocharged. While the general design of these types conforms to the Chicago Pneumatic line, there are many distinctive details. The engines are fully enclosed, as are all models, by oil- and dust-tight covers which are easily removed for access to parts.

BASE is marine type of cast semi-steel, heavily ribbed for stiffness with bearings lined-bored with caps in place to insure perfect alignment. Openings are provided under each main bearing for removing main bearing bolts. Openings are provided in each end for draining and for oil level gauges. Oil header cast in near top and feeds drilled passages to main bearings. Engine can also be supplied with a flat bottom base where conditions warrant.

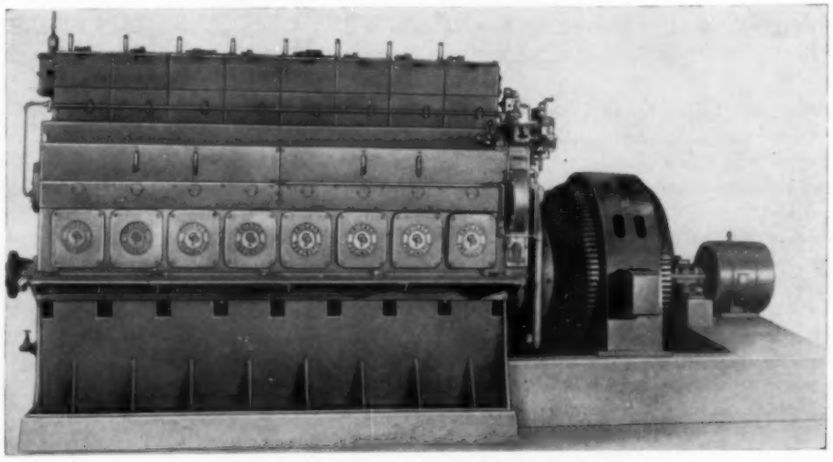
FRAME is of cast semi-steel so arranged in enbloc construction as to provide a header for both intake air and cooling water plus chambers for mounting camshaft and oil cooler. Large openings in the sides allow room for inspection and maintenance of crankpin and main bearings. Construction at top of cylinder block puts material at hottest part under compression rather than in tension, at the same time providing maximum area for flow of cooling water around top of liner. Bottom of cylinder is drilled for telltale water passage to outside of block, providing a means for determining when lower gaskets around the removable liner are in need of replacement. Large pipe plugs in the integral water header permit cleaning and draining.

CYLINDER HEADS are individual of alloy cast iron, completely water jacketed around all valves with large pipe plugs for cleaning. Inlet and exhaust valves, seat in the head except that inserts are used. Fuel injection valve in center of head is copper sheathed for maximum heat transfer. Air starting valve and indicator connection are included. Water outlet connection from each head has a valve for regulating temperature of cooling water. Heads may be removed without disturbing either inlet or exhaust manifold. Valve gear on top of head is enclosed by removable oil-tight aluminum cover.

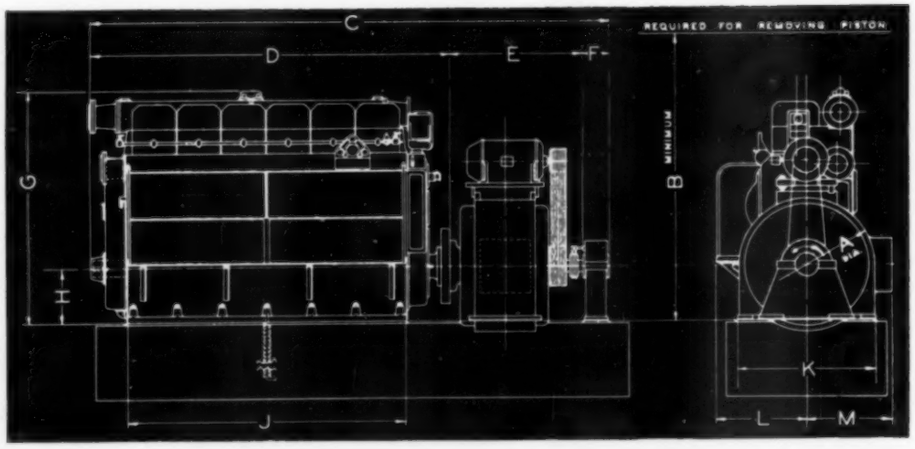
VALVES, inlet and exhaust, are special silichrome steel, stellite tipped on stem ends. Rocker bracket on head is alloy cast steel. Valve gear is completely enclosed by oil-tight steel covers.

CRANKSHAFT journals and pins are unusually large to prevent any possible difficulties from torsional vibration. Helical gear drive is mounted at the flywheel end to give a quiet, constant-speed drive to the camshaft and auxiliaries. Removable shell-type bearings are used.

FUEL SYSTEM includes an engine-driven fuel transfer pump drawing fuel from the storage tank and forcing it through a filter to the individual fuel pumps. Short lines connect the pumps to the nozzles. Through special design of cylinder headcovers, valve follower brackets and related parts, the fuel oil system is completely isolated from the lubricating oil system to prevent fuel dilution of lube oil.

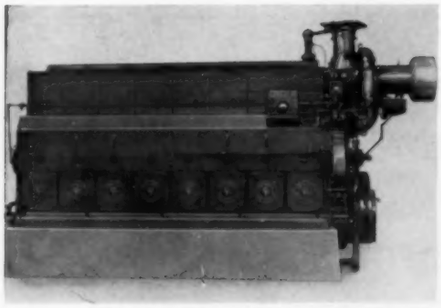


Type 112-CP, 8 cylinder Diesel Engine



DIMENSIONS TYPE 112-CP DIESEL

Size	A	B	C	D	E	F	G	H	J	K	L	M
312-CP	46	112	151	88½	52	10½	94½	22 7/16	58½	47	36⅝	30
412-CP	54	112	169	106¼	52	10½	94½	22 7/16	76¼	47	36⅝	30
512-CP	54	112	192	124	58	10½	94½	22 7/16	94	55	36⅝	30
612-CP	54	112	211	142½	58	10½	94½	22 7/16	111¾	55	36⅝	34
812-CP	64	112	249	178	60	10½	94½	22 7/16	147¼	68	36⅝	42



Type 112-CP, 8 cylinder, 1000 hp. turbocharged Chicago Pneumatic Diesel.

LUBRICATION is fully automatic to all parts including the overhead valve mechanism. A gear driven rotary lube oil pump mounted on the gear case at the flywheel end of the engine draws oil from the sump in the base and forces it through a lube oil filter and cooler to the main distribution header cast in the base. From there oil flows under pressure through drilled passages to main bearings, crankpin bearings and up the connecting rods to the wrist pins.

A second lube oil manifold, cast in the cambox and fed from the main lubricating oil system, carries oil to the camshaft bearings, cams, rollers and guides through drilled passages in the roller guide brackets. Hollow push rods transfer oil to drilled holes in the rocker arms which lubricate rocker arm bearings, valve stems, tappets, etc.

STARTING air valves in the cylinder heads are timed from the distributor mounted at the free end of the camshaft.

TURBOCHARGING is by Elliott system with the turbocharger mounted at the flywheel end of the engine as shown.

These engines are ruggedly built for continuous, heavy-duty service.

TYPES 123-CPS AND 125-CPS

The Chicago Pneumatic 123-CPS and 125-CPS supercharged engines are an addition to the CP line and feature high pressure turbocharging and air intercooling. The Type 123-CPS has cylinders 12 by 13 inches and is built in six, eight and ten cylinders at 720 rpm giving a range from 1365 to 2280 horsepower. The Type 125-CPS has cylinders 12 by 15 inches and is built in six, eight and ten cylinders at 514 rpm giving a range from 1125 to 1875 horsepower.

LOWER BASE is a wet sump, marine type cast iron, designed for maximum strength and rigidity with minimum weight. Base is heat treated before machining to remove internal stresses. Main bearing saddles solidly supported by ribs and transverse members.

CRANKSHAFT is fully machined from a single forged billet of heat treated alloy steel, completely balanced and drilled for pressure lubrication, it turns in lower base on steel-backed copper-lead lined, full precision main bearing shells. Extra large main and connecting rod journals and massive webs give the added rigidity and strength necessary to meet severe variable speed applications or sudden overloads. Complete engine including crankshaft is designed to comply with A.B.S. Specifications.

A-FRAME a normalized, one-piece casting designed for maximum strength and stiffness for minimum weight. Frame contains wet type, easily removable cylinder liners cast from special, long wearing liner iron, sealed against leakage at top with a copper gasket and at the bottom with the latest "O"-ring construction to provide for expansion. Large crankcase doors at each cylinder center on both sides of frame give access to main and connecting rod bearings, pistons, etc.

CAMSHAFT is installed in a separate tunnel in A-Frame, turns in automotive type, babbitt lined bearings, and is driven from crankshaft by heat treated helical gear train at flywheel end. Camshaft is removable from side without disturbing rest of gear train, a must in all marine applications, and in stationary service allows its removal without disassembling driven equipment. Large oil-tight covers over cam tunnel allow inspection of cams, rollers, cam followers, etc.

INDIVIDUAL CYLINDER HEADS are cast of high tensile strength, heat-resisting alloy iron. Easily removable without disturbing exhaust and intake manifolds that are installed on opposite sides of heads. 4-valve type, but departs from the conventional in that each pair of exhaust and intake valves are arranged parallel to crankshaft instead of at right angles, and are adjacent to their respective manifold. This special location of valves minimizes restrictions usually found in conventional 4-valve heads where flow of air or gas through the more distant valve interferes with flow through the second valve. With a more efficient flow of air and exhaust gas, the engine horsepower capacity is automatically raised with corresponding improvement in combustion and reduction in fuel consumption. Cylinder heads include valve seat inserts, dual valve springs, and oil-tight cylinder head covers. Top cover plate is removable, while engine is in operation, to expose complete overhead valve mechanism for inspection or service.

PISTONS are of special lightweight design cast from high tensile strength alloy iron. Fitted with four compression rings, two oil control rings and full floating hardened ground piston pins with aluminum caps. Oil spray removes heat from crown and ring belt.

CONNECTING RODS are die forged of heat-treated alloy steel. Oil passages, rifle drilled the length of the rod provide lubrication to bronze piston pin bushing, and oil to oil spray nozzle at the end of the rod. Crankpin end of rod fitted with steel backed, copper-lead lined, full precision connecting rod bearing shell replaceable without hand fitting.

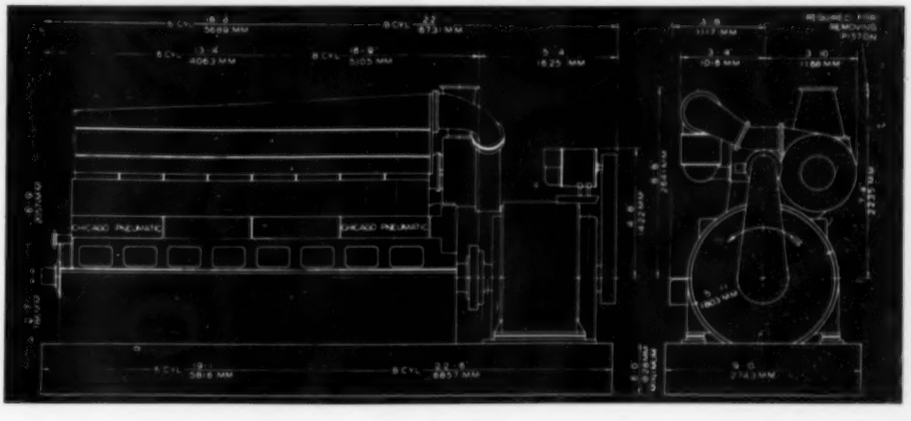
FUEL SYSTEM employs a Bendix-Scintilla individual injection pump and nozzle for each cylinder. Injection pumps are adjustable for separate timing and load adjustment between cylinders. Located on shelf above cam tunnel, behind dust tight covers, and being external to cam tunnel on outside of engine, they are, together with low and high pressure fuel piping, including manifold, completely isolated from lube oil system. This prevents dilution of lubricating oil by fuel.

Because of special design of cylinder head covers and related parts, injection nozzles with their system of high pressure and leak-off tubing are external to lubricating system of overhead valve mechanism. The auxiliary fuel pump and drive shaft seal are separate from lube oil system. Fuel leakage is drained through a system of manifolding.

FULL PRESSURE LUBRICATION is supplied to all moving parts of engine including overhead valve mechanism by a gear driven, high capacity, rotary lube oil pump with built-in relief valve, located at flywheel end. No part of engine needs lubrication by hand. A full-flow, edge type strainer is standard equipment with an installed, hand operated lube oil pump to prime system and flood all friction surfaces with an oil film before starting.

ENGINE COMPLETELY ENCLOSED IS DUST TIGHT and its large covers and hand hole plates allow easy access to all parts of engine for inspection and service.

Model 823-CPS-DF Dual-Fuel Engine.



TYPE 16-CP

This type has 16 inch diameter cylinders with a stroke of 20 inches to operate at 360 rpm. and a stroke of 22 inches to operate at 327 rpm. Built in four, five, six and eight cylinders, turbocharged as well as naturally aspirated, a wide choice of units gives a range of from 550 to 1750 horsepower. Engines are fully enclosed and standard accessories are externally mounted and removable as complete units to facilitate ready repair or replacement.

BASE is of box section, heavily ribbed under the main bearings and with deep sections at each side to impart longitudinal stiffness. Frame is of high tensile alloy iron, of ample section and well ribbed to give rigidity against gas loads, bending, and vibration stresses. Crankshaft journals and pins are unusually large to prevent any possible difficulties due to torsional vibration. Silent chain drive mounted at the flywheel end gives a quiet, steady drive for the camshaft.

BEARING SHELLS are of removable type. Heavily stressed studs and bolts are of nickel chrome steel. One inlet and one exhaust valve per cylinder head are carried in removable cages as shown in the detail picture.

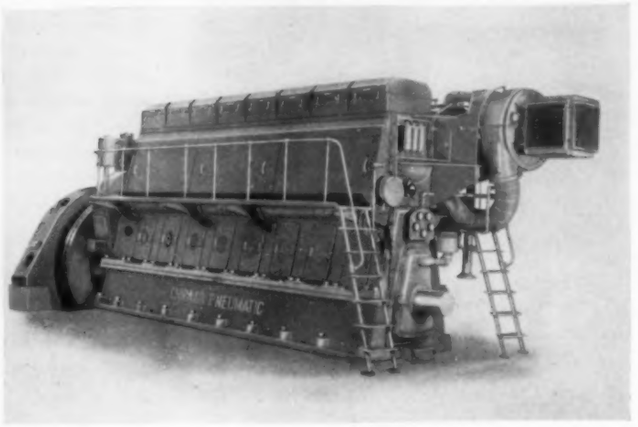
FUEL INJECTION PUMPS are individual, located at their respective cylinders, and operated direct from the camshaft. They are in the enclosure at the side of the frame with the camshaft and valve gear. Short pipes lead to the fuel injectors in the centers of the cylinder heads.

LUBRICATION is automatic to all bearings and flywheel parts needing oil. The engine driven pump at the end of the engine draws oil from the sump in the base and forces it through a filter and cooler to the main distribution header cast into the base. From there, oil flows through drilled passages to main bearings, to crankpin bearings, and up connecting rods to the wrist pins.

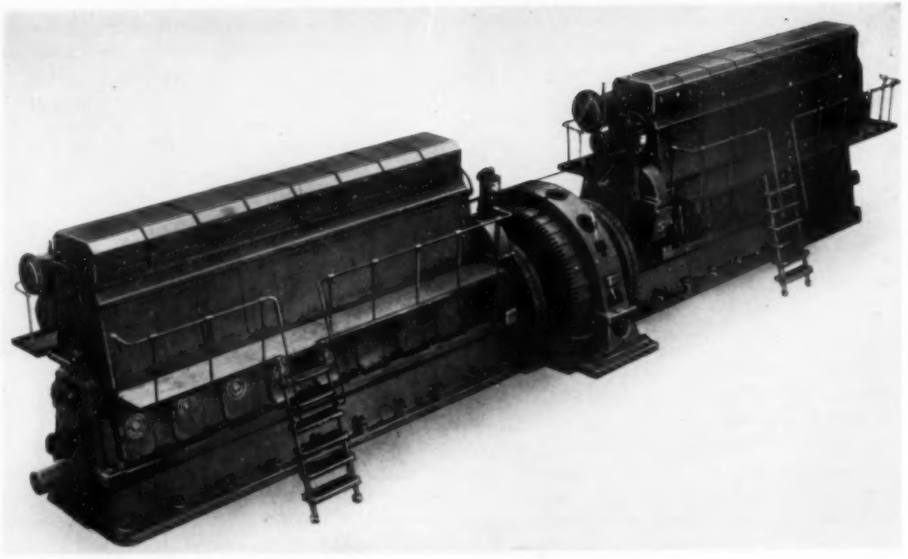
A secondary oiling system, entirely separate from the main system, provides lubrication for camshaft and valve gear. Camshaft trough serves as sump and gear type pump delivers oil through supply pipe direct to cam followers and camshaft bearings, and through other pipes to rocker arm pivots. Drilled passages in the pivots conduct the oil to the rocker arm bearings. From there, oil is carried through drilled holes in the rocker arms to the valve stems, and also to the ball joints between push rods and locker arms.

In addition, cylinder lubrication is provided by two force feed lubricators driven from the camshaft and enclosed under the camshaft covers. These are shown along with one of the fuel pumps and the air piping in the detail picture.

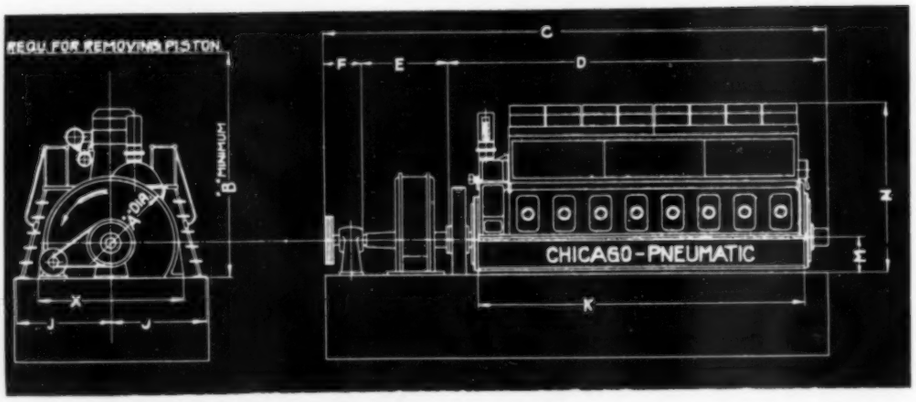
Starting air valves in the cylinder heads are timed by their respective pilot valves located as shown at each cylinder and actuated by the camshaft.



Type 16-CP, 8 cylinder, 1750 HP, Turbocharged Chicago Pneumatic Diesel Engine.

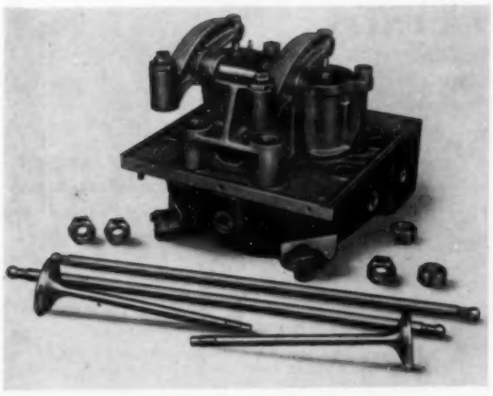


Chicago Pneumatic 862-CP Twin Generator Set.



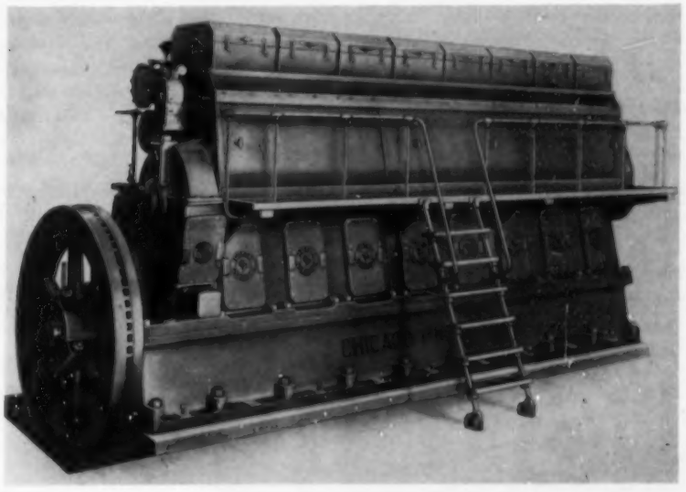
DIMENSIONS TYPE 16 DIESEL

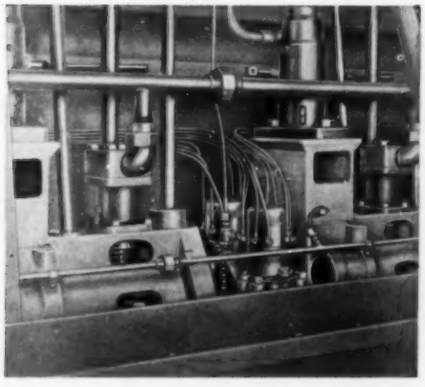
Size	A	L	C	D	E	F	J	K	M	N	X
360-CP, 362-CP	72	162	225	145	58	22	71	106	26¾	125	73
460-CP, 462-CP	84	162	253	171	58	24	71	132	26¾	125	85
560-CP, 562-CP	84	162	281	197	60	24	71	158	26¾	125	85
660-CP, 662-CP	84	162	311	223	62	26	71	184	26¾	125	85
860-CP, 862-CP	100	162	363	275	62	26	71	236	26¾	125	106



Cylinder Head Assembly.

Shown below is an eight cylinder unit with ladder and platform provided on each side of the engine to give access to the top parts. Exhaust and air pressure headers run along the length of the engine in the rear.





Chicago Pneumatic Type 16-CP Diesel Engine.

Fuel Pumps, Air Piping, and Force-Feed Lubricators.

CHICAGO PNEUMATIC DIESELS

Model	Cycle	HP.	Cyls.	Bore	Stroke	R.P.M.	Fuel System	Weight	Starting
39-CP	4	150	3	9	10½	720	Bendix-Scintilla	8900	Air
49-CP	4	195	4	9	10½	720	Bendix-Scintilla	10690	Air
69-CP	4	300	6	9	10½	720	Bendix-Scintilla	14240	Air
69-CPS	4	450	6	9	10½	720	Bendix-Scintilla	15740	Air
89-CP	4	395	8	9	10½	720	Bendix-Scintilla	16750	Air
89-CPS	4	600	8	9	10½	720	Bendix-Scintilla	18250	Air
412-CP	4	330	4	11	12	720	Bendix-Scintilla	21200	Air
412-CPS	4	500	4	11	12	720	Bendix-Scintilla	23400	Air
512-CP	4	415	5	11	12	720	Bendix-Scintilla	25300	Air
512-CPS	4	630	5	11	12	720	Bendix-Scintilla	27500	Air
612-CP	4	500	6	11	12	720	Bendix-Scintilla	28400	Air
612-CPS	4	750	6	11	12	720	Bendix-Scintilla	31600	Air
812-CP	4	670	8	11	12	720	Bendix-Scintilla	32800	Air
812-CPS	4	1000	8	11	12	720	Bendix-Scintilla	35700	Air
414-CP	4	335	4	11	14¼	600	Bendix-Scintilla	22200	Air
414-CPS	4	550	4	11	14¼	600	Bendix-Scintilla	24400	Air
514-CP	4	420	5	11	14¼	600	Bendix-Scintilla	25200	Air
514-CPS	4	685	5	11	14¼	600	Bendix-Scintilla	28600	Air
614-CP	4	500	6	11	14¼	600	Bendix-Scintilla	29800	Air
614-CPS	4	825	6	11	14¼	600	Bendix-Scintilla	32000	Air
814-CP	4	660	8	11	14¼	600	Bendix-Scintilla	34500	Air
814-CPS	4	1100	8	11	14¼	600	Bendix-Scintilla	36000	Air
623-CPS	4	1365	6	12	13	720	Bendix-Scintilla	39000	Air
823-CPS	4	1820	8	12	13	720	Bendix-Scintilla	47000	Air
1023-CPS	4	2280	10	12	13	720	Bendix-Scintilla	55000	Air
625-CPS	4	1125	6	12	15	514	Bendix-Scintilla	39000	Air
825-CPS	4	1500	8	12	15	514	Bendix-Scintilla	47000	Air
1025-CPS	4	1875	10	12	15	514	Bendix-Scintilla	55000	Air
460-CP	4	600	4	16	20	360	Bendix-Scintilla	64700	Air
460-CPS	4	875	4	16	20	360	Bendix-Scintilla	68130	Air
462-CP	4	600	4	16	22	327	Bendix-Scintilla	64700	Air
462-CPS	4	875	4	16	22	327	Bendix-Scintilla	68130	Air
560-CP	4	750	5	16	20	360	Bendix-Scintilla	72800	Air
560-CPS	4	1100	5	16	20	360	Bendix-Scintilla	76540	Air
562-CP	4	750	5	16	22	327	Bendix-Scintilla	72800	Air
562-CPS	4	1100	5	16	22	327	Bendix-Scintilla	76540	Air
660-CP	4	900	6	16	20	360	Bendix-Scintilla	80900	Air
660-CPS	4	1350	6	16	20	360	Bendix-Scintilla	84950	Air
662-CP	4	900	6	16	22	327	Bendix-Scintilla	80900	Air
662-CPS	4	1350	6	16	22	327	Bendix-Scintilla	84950	Air
860-CP	4	1200	8	16	20	360	Bendix-Scintilla	101440	Air
860-CPS	4	1800	8	16	20	360	Bendix-Scintilla	106800	Air
862-CP	4	1200	8	16	22	327	Bendix-Scintilla	101440	Air
862-CPS	4	1800	8	16	22	327	Bendix-Scintilla	106800	Air

S—Turbo-supercharged. All engines can be furnished as dual-fuel or spark ignited gas units. All Units for Stationary Service.

SHEPPARD

20 TO 78 H.P. POWER UNITS

FAN TO FLYWHEEL . . . Sheppard diesel fan-to-flywheel engines. Available for users desiring to furnish their own radiator and clutch.

OPEN POWER UNITS . . . Complete with radiator, clutch and stub-shaft . . . easily and quickly incorporated into present equipment or coupled to driven machinery.

STANDARD POWER UNITS . . . Include radiator, engine hood, fuel tank, clutch and stub-shaft. For indoor installations.

ENCLOSED POWER UNITS . . . Complete unit with all standard equipment plus sheet metal enclosure and radiator grille. For use on exposed locations.

Sheppard diesels are equally suited for either original equipment or replacement power. They offer important power cost savings wherever small gasoline engines require constant maintenance and frequent replacement. And, wherever on-the-job fuel pilferage adds considerably to the cost of operating gasoline power.

With the Sheppard simplified fuel injection system, Sheppard diesels present no unusual service problem to either equipment manufacturer or power user. Since all wearable parts are easily replaced, a Sheppard diesel has a long on-the-job life.

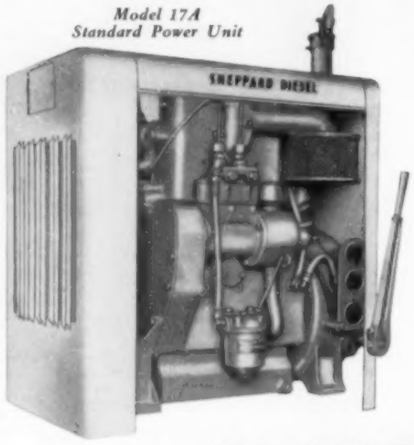
Sheppard diesels are easily installed . . . require no changes in equipment design. Most Sheppard diesels measure less overall than their equals in gasoline power. They add but little to the total weight of any machine.

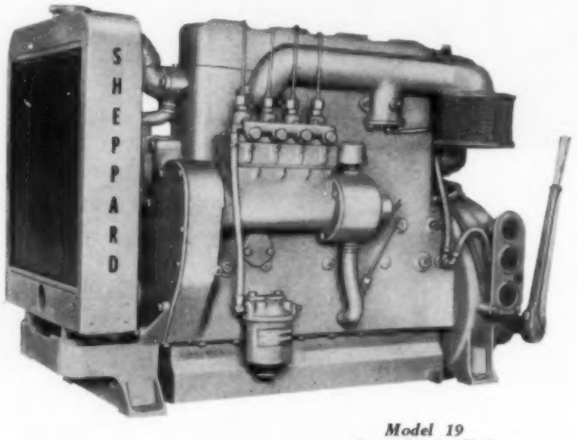
By concentrating production on fewer basic engines, Sheppard is able to offer diesel comparable in price to gasoline power.

Because of their interchangeability with gasoline engines, these versatile Sheppard diesels are being widely offered as optional equipment by many equipment manufacturers to meet the heavy-duty service requirements of their customers.

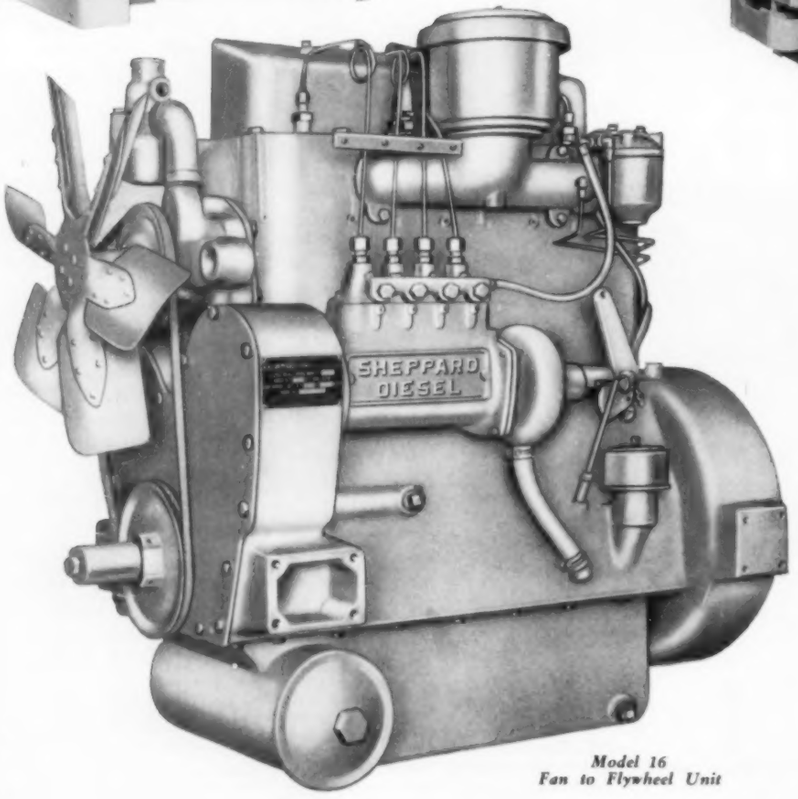
Sheppard diesels are available as complete power packages including reduction gears, transmissions, torque converter or any other equipment to meet special needs.

Model 17A
Standard Power Unit





Model 19
Open Power Unit



Model 16
Fan to Flywheel Unit

SPECIFICATIONS			
Model No.	17A	19	16
Gross BHP @ 2000 RPM	20	42	78
Intermittent BHP @ 1800 RPM	15	31	66
Continuous BHP @ 1800 RPM	13.5	28	54
Bore—Inches	3½	3½	4½
Stroke—Inches	4	4	5
No. Cylinders	2	4	4
Cycle	4	4	4
Displacement (Cu. In.)	76.8	153.6	318
Rotation (At Gear End)	RH	RH	RH
Governor Regulation	5-7%	5-7%	5-7%
Starting—Electric	12V	12V	12V
Flywheel Housing	SAE-5	SAE-5	SAE-3
No. Main Bearings	3	5	5
Weight (Fan to Flywheel)	435	600	1256
Piston Speed @ 1200 RPM	800 FPM	800 FPM	1000 FPM
Compression Ratio	22-1	22-1	22-1
K. W.	5 • 7½	10 • 12 15	20 • 25 30 • 35

Specifications subject to change without notice

5 TO 35 K.W. GENERATING SETS

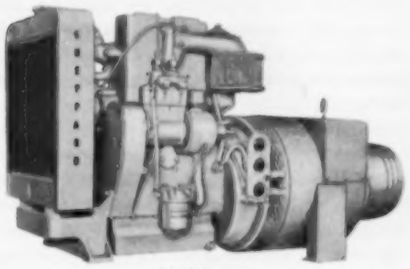
For dependable night lighting or wherever close voltage regulation is a critical factor

Sheppard Diesel Generating Sets provide complete protection against highline power failure or voltage drop.

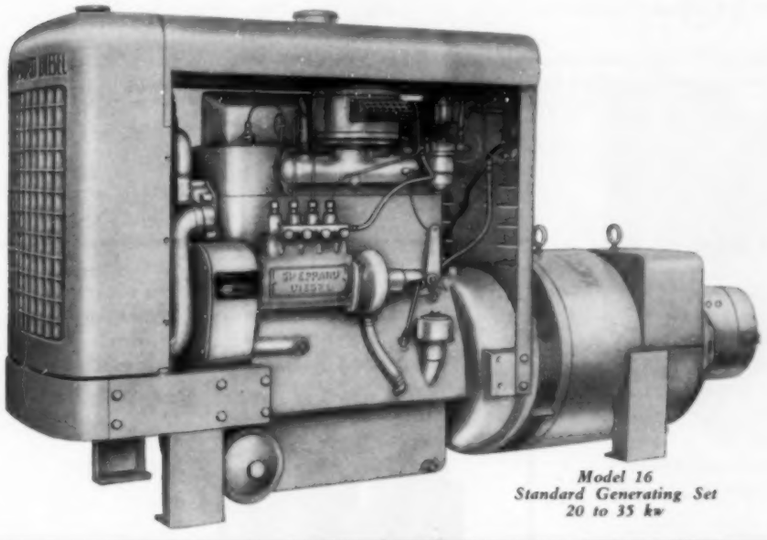
In the critical field of electronics and communications, Sheppard diesels are widely used because of their extremely close governor regulation. In many installations, a Sheppard diesel is used only for stand-by service to level off "dips" in highline voltage during peak load periods.

Often two Sheppard diesels are used to provide both main and stand-by power. The two units alternate as the main power source through the use of fully automatic controls. Automatically controlled Sheppard diesel generating sets find wide applications in schools, hospitals and homes . . . on farms and on shipboard . . . and in modern industry. In fact, anywhere that dependable electrical power is essential.

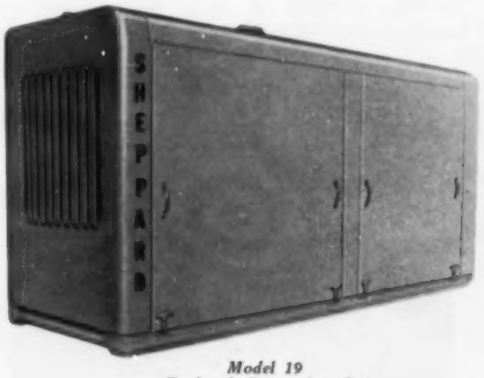
AUTOMATIC CONTROLS . . . Various types of controls increase the versatility of a Sheppard diesel generating set. Power or line failure starting automatically starts generator when main power fails . . . shuts off unit when power is resumed. Load demand starting automatically starts generating set the instant any load is placed on the system . . . stops when load is removed. REMOTE STATION STARTING automatically controls set by use of temperature switch, pressure switch or float switch. MANUAL REMOTE STATION STARTING consists of a simple switch, at some convenient location, used to stop or start engine.



Model 17A
Open Generating Set
5 to 7½ kw



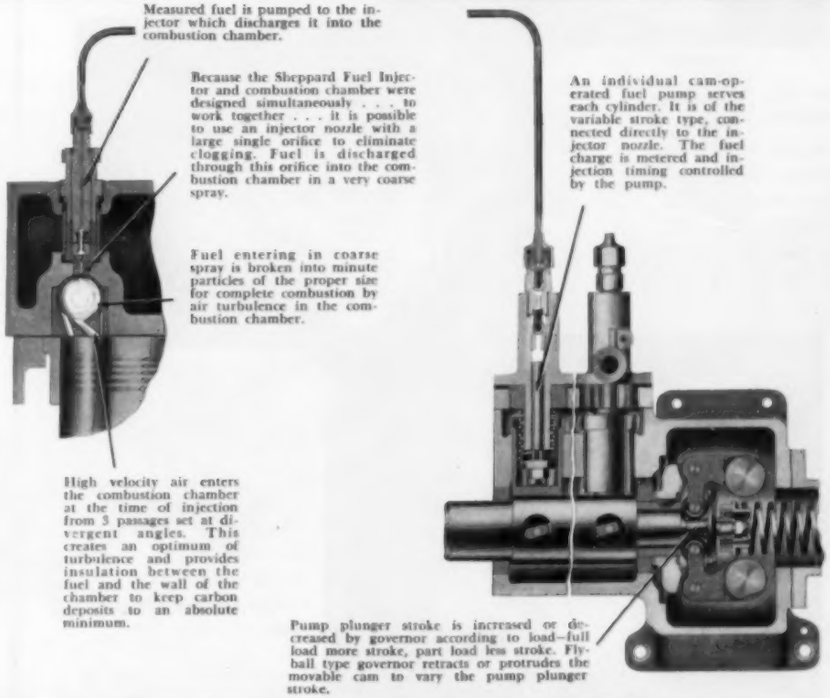
Model 16
Standard Generating Set
20 to 35 kw



Model 19
Enclosed Generating Set
10 to 15 kw

The entire Sheppard fuel injection system including fuel pump, injector nozzle and combustion chamber are Sheppard designed and Sheppard built for use only in the Sheppard diesel engine. Because of the simplicity and efficiency of this fuel injection system, a Sheppard diesel will operate on a wider range of fuels than most other engines. Although #2 furnace oil or any diesel fuel is usually used, Sheppard diesels have been operated efficiently on dozens of mineral and vegetable oils.

Maximum diesel operating economy assured by 22 TO 1 COMPRESSION RATIO. The fuel economy of Sheppard diesel engines is a direct result of the Sheppard simplified fuel injection system . . . plus a 22 to 1 compression ratio one of the highest in use today. This high compression ratio assures maximum fuel combustion efficiency . . . maximum power from every drop of fuel. Consequently, Sheppard diesel owners realize up to 75% savings on fuel costs over gasoline power. It is also one of the main reasons Sheppard diesels start fast even at low temperatures.


Measured fuel is pumped to the injector which discharges it into the combustion chamber.
Because the Sheppard Fuel Injector and combustion chamber were designed simultaneously . . . to work together . . . it is possible to use an injector nozzle with a large single orifice to eliminate clogging. Fuel is discharged through this orifice into the combustion chamber in a very coarse spray.
Fuel entering in coarse spray is broken into minute particles of the proper size for complete combustion by air turbulence in the combustion chamber.
High velocity air enters the combustion chamber at the time of injection from 3 passages set at divergent angles. This creates an optimum of turbulence and provides insulation between the fuel and the wall of the chamber to keep carbon deposits to an absolute minimum.
An individual cam-operated fuel pump serves each cylinder. It is of the variable stroke type, connected directly to the injector nozzle. The fuel charge is metered and injection timing controlled by the pump.
Pump plunger stroke is increased or decreased by governor according to load—full load more stroke, part load less stroke. Flyball type governor retracts or protrudes the movable cam to vary the pump plunger stroke.

Heavy Duty Construction brings "Big Engine" Dependability to the small engine field—Sheppard's simplified design results in a comparatively lightweight diesel of heavy-duty construction. This same simplicity of design and heavy-duty construction accounts for the ease with which a Sheppard diesel can be operated, serviced and maintained. The whole idea in building the Sheppard diesel was to make a compression ignition engine simple enough to be readily understood and operated by persons with no diesel experience . . . one that could be serviced by the average mechanic under field conditions. Every Sheppard design has been planned to eliminate as many parts as possible . . . especially small parts. Those small parts that were retained were made as large as good engineering practice would permit. The result . . . dependable operation in heavy-duty service for users of small engines.

ENGINE BLOCKS—Sheppard blocks are cast in one piece. The upper part of the crankcase is made of special high strength cylinder block iron. All Sheppard blocks are cast in the Sheppard foundry where the know-how required to produce castings for heavy-duty diesel service has been developed over two decades.

CYLINDER LINERS—Distortion free, heat treated iron liners of the wet type are used in all Sheppard diesels. They are machined all over. Sheppard liners are held in place by the heads and are easily replaceable.

CYLINDER HEADS—Cast in one piece of close grained iron. Sheppard heads are held in position by heat treated cap screws tapped into the block making for easy replacement in case of damage. Alloy valve seat inserts automatically compensate for any cylinder head distortion present during the warm-up period. Special heat resisting steel inserts in the head form the lower two-thirds of the combustion chambers.

CRANKSHAFTS—Sheppard crankshafts are precision ground and dynamically balanced. They are rifle drilled for full pressure lubrication.

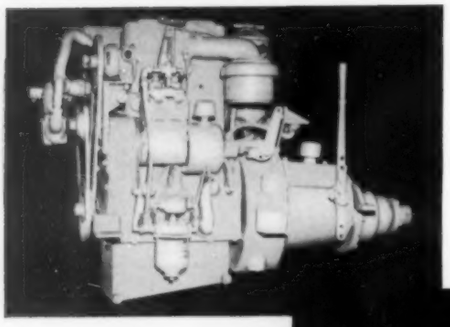
CONNECTING RODS—Sheppard connecting rods are of the I beam type, rifle drilled for pressure lubrication. They are precision honed to receive bearing shells. Bearing caps are dowelled for perfect alignment.

BEARINGS—Precision type, tri metal bearings, copper backed with lead-tin overlay, are easily replaceable. The same shells fit all main and connecting rod bearings on the Model 17A and 19 thus simplifying spare parts inventories. Main bearings are used at both ends of the crankshaft and between each throw on all Sheppard engines.

PISTONS—The pistons used in Sheppard diesels are cast of special high strength piston iron. 3 compression and 2 oil rings are used. Sheppard pistons are spray cooled. Directionally formed in relation to the heat pattern beneath combustion chamber, Sheppard oil spray cooling prevents distortion of the piston crown. Sheppard pistons are especially designed to handle today's high sulphur fuels without sticking rings or scarred cylinder walls.

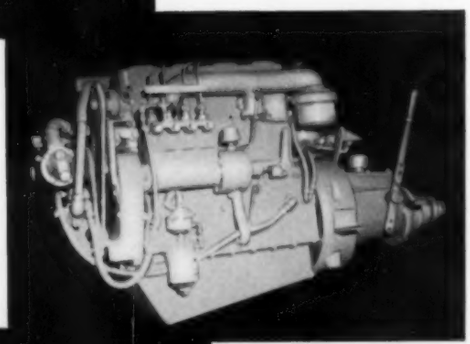
PISTON PINS—Sheppard diesels use full floating pins to distribute wear over twice the bearing sur-

20 TO 78 H.P. MARINE ENGINES



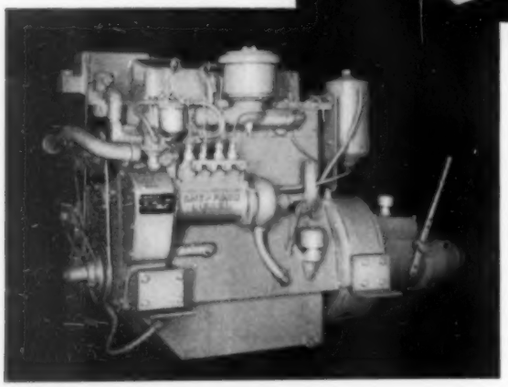
20 H.P.
MODEL 17A

Height Overall—27⅝″
Height above crankshaft centerline—18⅞″
Width Overall—18″
Length Overall with 1 to 1 Reduction Gear—35¾″



42 H.P.
MODEL 19

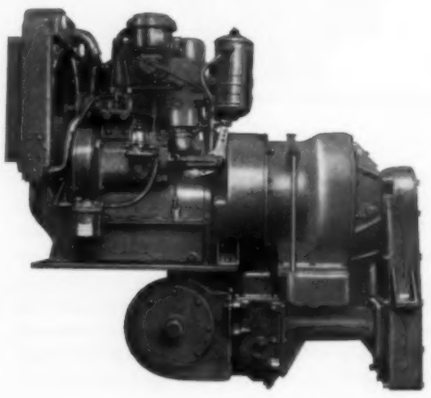
Height Overall—27⅝″
Height above Crankshaft centerline—18⅞″
Width Overall—18″
Length Overall with 1 to 1 Reduction Gear—45⅞″



78 H.P.
MODEL 16

Height Overall—39 5/16″
Height above crankshaft centerline—28 1/16″
Width Overall—23″
Length Overall with 1 to 1 Reduction Gear 56″

Complete Power Drives to Meet Individual Needs



Because the Sheppard organization is highly specialized it can profitably cope with the problems of engine buyers whose requirements are unusual and exacting. Sheppard diesels are available as complete power drives including reduction gears, transmissions, torque converters or any other equipment desired to meet special needs. The 20 hp Sheppard with torque converter shown above measures less than 46″ overall. It was developed to meet the special power needs of a new mine locomotive which can start and haul 100 ton pay loads at efficient speeds.

face. Bearing area occurs in both piston and piston pin which actually doubles the bearing surface.

CAMSHAFTS—Gear driven camshafts are pressure lubricated on Model 17A and 19 Sheppard diesels. All wearing surfaces are hardened and precision ground for long, trouble free service.

COOLING SYSTEMS—High output pump assures positive water circulation for efficient heat removal. Sealed-for-life ball bearing never needs lubrication. Automatically adjusted carbon seal never needs adjustment. Models 17A and 19 use a bellows type thermostat, the Model 16 a by-pass type, to automatically regulate water temperature for most efficient engine performance at all times.

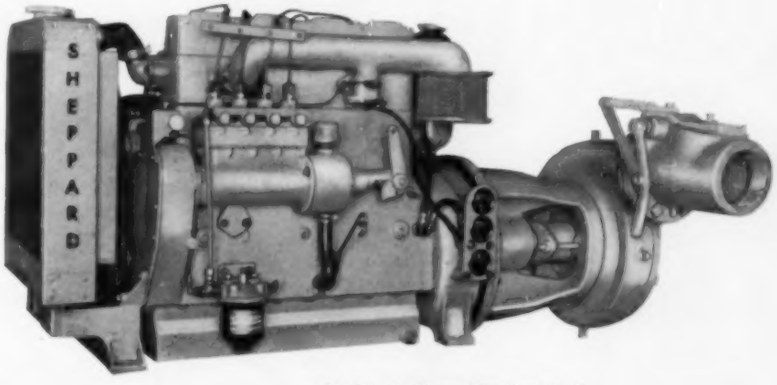
LUBRICATION SYSTEM—All parts of a Sheppard diesel are automatically lubricated by a force fed system using a replaceable by-pass cartridge type filter. Fulflo filtration is available on the Model 16. The gear type oil pump, with all parts precision ground, is assembled without gaskets. Crankshaft and connecting rods are rifle drilled. Camshaft and rocker arms are pressure lubricated on Models 17A and 19, optional on the Model 16. Both fuel pumps and governor are lubricated by the engine lubrication system. While use of detergent lube oil is perfectly acceptable it is not necessary.

GOVERNOR—The Sheppard governor is extremely sensitive to the slightest load change. It is a fly ball type, designed by Sheppard in conjunction with the simplified Sheppard fuel injection system. The Sheppard governor provides close regulation within 3½%. That's why Sheppard diesels for generator work insure constant voltage without the surge and droop so common in other types of power. Because of Sheppard's super-sensitive governor, Sheppard diesels parallel extremely well in generating service.

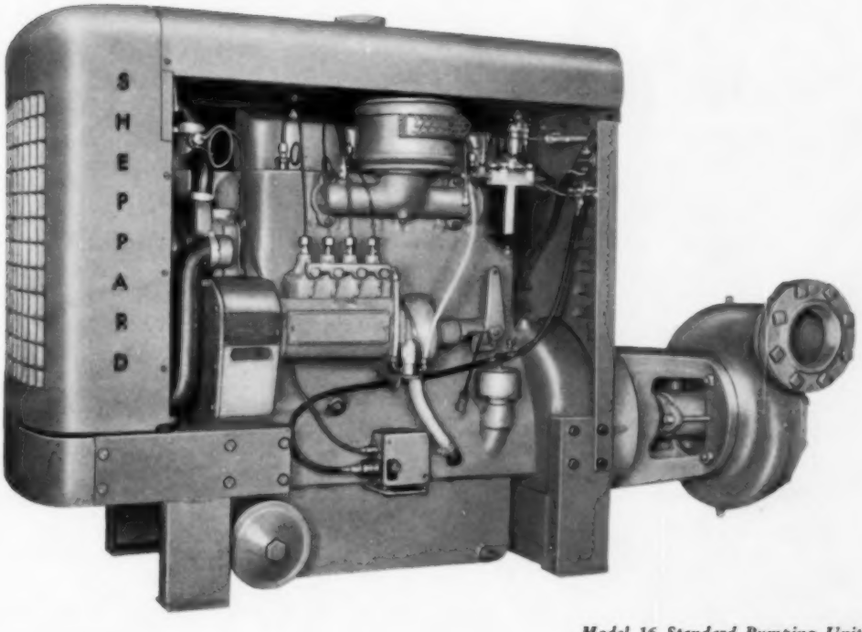
FUEL INJECTION SYSTEM—The Sheppard fuel injection system was developed as an integral part of the Sheppard diesel. It is built entirely by Sheppard for exclusive use in Sheppard engines. It is an outstanding example of dependability through simplicity. The Sheppard fuel injection system can be serviced in the field without special tools by mechanics without special training. A complete, detailed description of the simplified Sheppard fuel injection system appears on the preceding pages.

120 TO 1140 G.P.M. PUMPING UNITS

All Sheppard Diesels are available as pumping units for irrigation, construction and general service. The engines are direct-connected to centrifugal type pumps. Pumps are equipped with primers and semi-automatic discharge valves for priming purposes. Flanged suction has openings for liquid fertilizer injection, exhaust primer and suction gauge. The flanged discharge is tapped for a fertilizer agitation line.



Model 19 Open Pumping Unit
475 TO 750 G.P.M.



Model 16 Standard Pumping Unit
700 TO 1140 G.P.M.

Model 17A Closed Pumping Unit
120 TO 580 G.P.M.

CUMMINS

AUTOMOTIVE, INDUSTRIAL AND MARINE DIESELS

CUMMINS, the pioneer manufacturer of light weight, high speed diesels, has developed a line of engines to cover an extremely wide range of applications requiring engines from 60 to 600 horsepower. A continuing research program since 1919 has reduced the weight of Cummins Diesels from several hundred pounds per horsepower to less than eight pounds per horsepower for the newest models.

Cummins Diesels are the most widely used diesel engines for heavy-duty highway trucks, for industrial switching locomotives, and in the logging industry. Large numbers of these engines are also used in off-highway trucks, earthmovers, shovels and cranes, city and intercity buses, oil well drilling rigs, fishing boats, tug boats, dredges and many other heavy-duty applications.

Some reasons for the success of these engines, in this wide variety of applications, are:

(1.) Low fuel consumption resulting from the characteristics of the Exclusive Cummins Fuel System. This system results in minimum variation in fuel consumption per horsepower throughout the engine's speed-load operating range. This metering and injection arrangement also is capable of operating on the lowest priced diesel fuels.

(2.) Light weight design makes their use in a wide range of mobile, portable, and stationary applications possible.

(3.) Rugged design gives long service life, low maintenance costs, and dependability.

(4.) Factory inspection and tests give uniformity of product and assures that the engine will deliver rated power on the job.

(5.) An outstanding service organization with over 200 service and parts locations in the U.S. and Canada and 93 in foreign countries assures rapid service everywhere.

130 Models Available

Over 130 models with various accessory arrangements are available. 20 automotive models are listed in table 1. Table 2 lists 79 industrial engine and power unit models and table 3 shows the 19 marine models. Twelve standard generator units are built. Additional accessories and optional equipment are available to meet individual application requirements. A complete line of torque converter units also is built. All Cummins Diesels are of the four cycle type and the basic design of all engines is similar. The JT-6 engine shown in the sectional view below is typical of all models.

Cylinder block and crankcase are one piece alloy iron castings of extremely high tensile strength. Removable, wet type cylinder liners fit snugly into the block and are sealed by the use of rubber rings. The timing gear train is located at the front of the cylinder block and controls all valve, injector and fuel pump action. Cylinder heads are replaceable as units. Some models include dual intake and exhaust valves and other models have single intake and exhaust valves. All valves are of the overhead type.

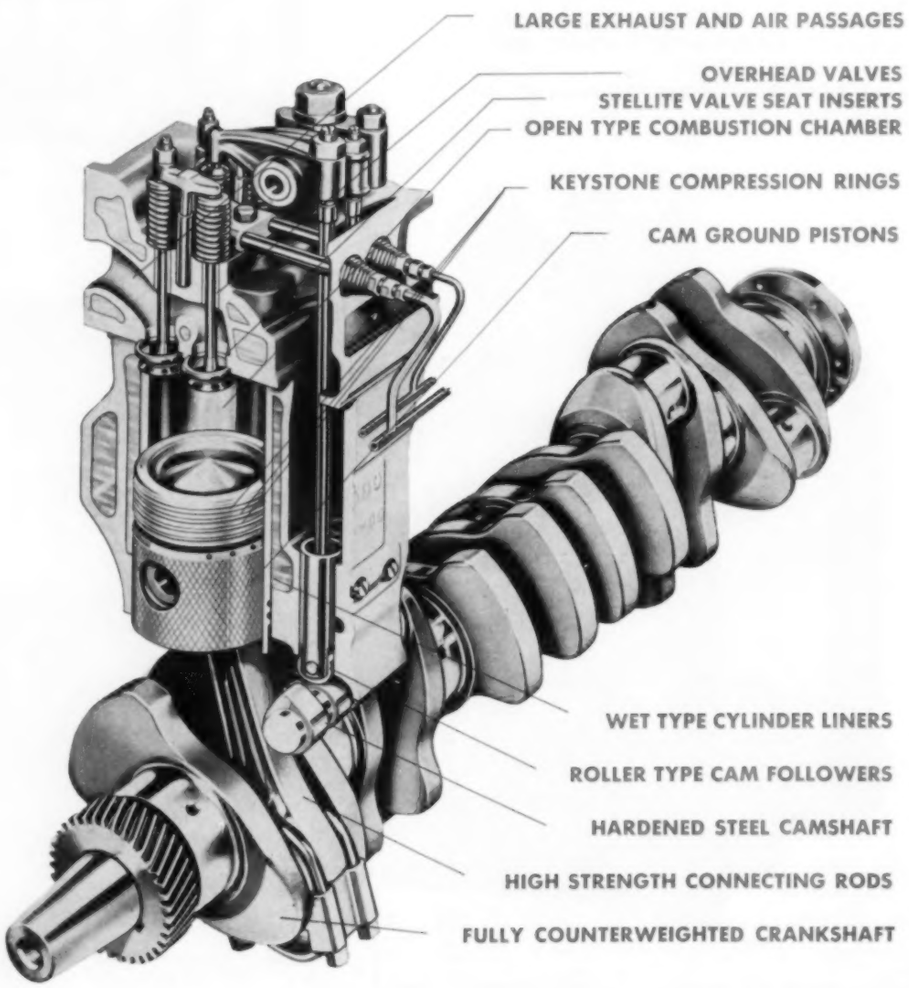
Vibration dampers are supplied on all models having a maximum governed speed of 2000 rpm. and over. The model JT-6, and all engines over 200 hp. are equipped with lubricating oil coolers. All models have pressure lubrication to main and connecting rod bearings. Pistons on most models have knurled skirts to give the best possible lubrication of the piston and cylinder liner.

Crankshafts are large diameter, high strength steel forgings with all bearing journals induction-hardened. Bearings are removable, precision type, copper-lead shells. The camshaft is carburized and hardened to assure maximum life in service.

Seven new models, the JT, NT4, NT6, NTO, NRT, NRTO, and VT are equipped with turbochargers designed and manufactured by Cummins. The turbocharger utilizes the heat of the exhaust to drive a turbine which, in turn, drives a centrifugal blower. This pumps additional air into the combustion chamber, allowing more fuel to be burned, and creating additional horsepower. Increases of 50% and more are gained in horsepower, with only slight increases in size and weight.

Some other models are supercharged. These are identified by an "S" in the model designation. These models are equipped with a Roots type blower, gear driven from the engine's timing train. These models also develop more power than naturally-aspirated engines with only a slight increase in size and weight.

Accessories available for specific types of applications are described in the material covering Automotive, Industrial and Marine engines.



CUMMINS *TURBODIESEL*® ENGINES

Eight new industrial *TURBODIESEL* engines are setting new records for performance, economy and light weight per horsepower. These are the 165 horsepower NT-4, the 175 horsepower JT-6, the 250 horsepower NT-6, the 262 horsepower NTO-6, the 300 horsepower NRT-6, the 335 horsepower NRTO-6, the 450 horsepower LRT-6, and the 600 horsepower VT-12. Air flow characteristics of the turbochargers used on these engines have been engineered to utilize the variable fuel flow rate of the PT Fuel System and produce engines with high horsepower, fast acceleration, and ideal torque characteristics.

A Cummins *TURBODIESEL* engine utilizes the normally wasted energy of exhaust gases, by means of a turbocharger, to develop additional horsepower. A turbine, located in the exhaust system drives a centrifugal blower in the air intake system. By forcing a greater weight of air into the cylinders, more fuel can be burned completely and more power developed. This gives operators these advantages over gasoline engines and other types of diesels: 1. Greater fuel economy; 2. More power without increased size; 3. Reduced weight per horsepower; 4. Less power loss at high altitudes.

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NRTO-6-B Turbodiesel engine with Cummins T-590 Turbocharger

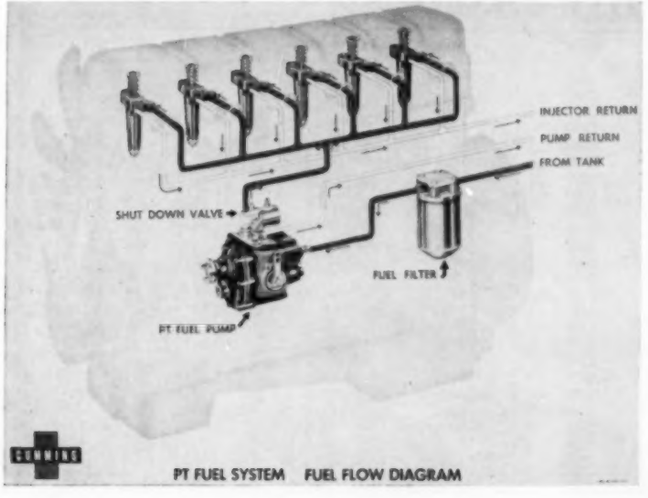
THE CUMMINS PT FUEL SYSTEM

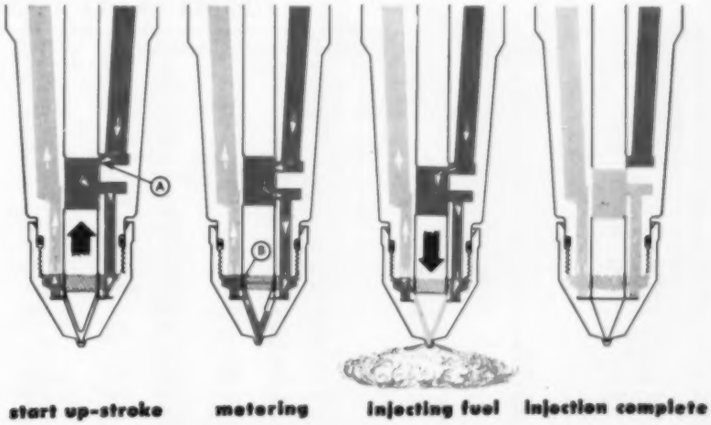
The *Pressure-Time principle* of fuel metering utilizes a fixed size opening in a simple injector and variable pressure to meter the fuel charge. The pressure at the metering opening is controlled by the throttle. The time interval during which the metering opening is uncovered is determined by the injector plunger. Because the plunger is actuated by the camshaft, engine rotative speeds establish the time interval for metering.

Pressure, and, consequently, the metering of fuel in the engine's operating range is controlled by the throttle. A simple mechanical governor controls the pressure at idling speed and at governed speed.

The injector plunger pushes the fuel charge into the combustion chamber as an extremely fine spray. As the motion of the injector plunger is controlled by the engine camshaft, injection and ignition occur at the same piston position at all engine rotative speeds. This feature gives Cummins Diesels their outstanding fuel economy—at all loads and speeds—with all commercial grades of diesel fuel.

Arrangement of PT fuel pump and injectors on the engine are shown below. A single line from the fuel pump provides equal pressure at each injector, assuring equal metering of fuel for all cylinders. The system may be calibrated by a simple screw adjustment on the fuel pump, without removing the pump from the engine.





Fuel Metering and Injection Cycle of Cummins PT Injector

CUMMINS AUTOMOTIVE DIESELS

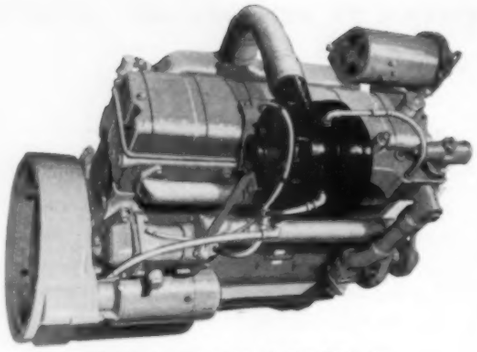
Cummins manufactures a line of automotive diesels primarily intended for use in heavy duty trucks and buses. These engines, for many years, have been the most widely used diesel in over-the-highway trucking service. Since 1952, over 50% of all diesel trucks registered in the U. S. were equipped with Cummins engines.

During 1955 and 1956, six new turbodiesels were added to the line. They are the 175 hp model JT-6-B, 250 hp model NT-6-B and NHHT-6 (horizontal), 262 hp model NTO-6-B, the 300 hp model NRT-6-B, 300 hp model NHHRT-6-B (horizontal) and 335 hp model NRTO-6-B. In addition, four naturally-aspirated models, the 95 hp J-6-B, the 105 hp model JF-6-B, the 125 hp JN-6-B, and the 125 hp NHCB-400 have been released. One supercharged model, the 165 hp JNS-6-B also has been announced.

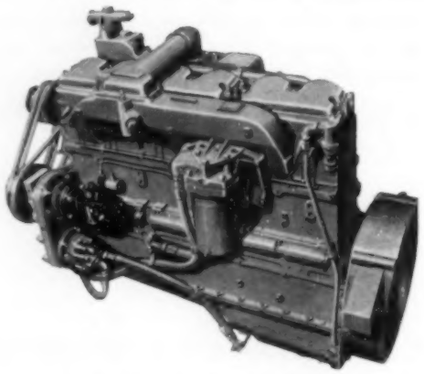
These new models extend the range of Cummins for automotive applications and gives truckers and bus operators higher horsepower in smaller and lighter engines.

The horizontal models HHRB-600, NHHB-600, NHHT-6, NHHRT-6 and NHHRBS-600 are of special interest. These engines were designed for underfloor installation in buses to give additional seating capacity. Truck manufacturers also have adapted these engines to new trucks to give a greater loading area without exceeding overall length limitations of the various states.

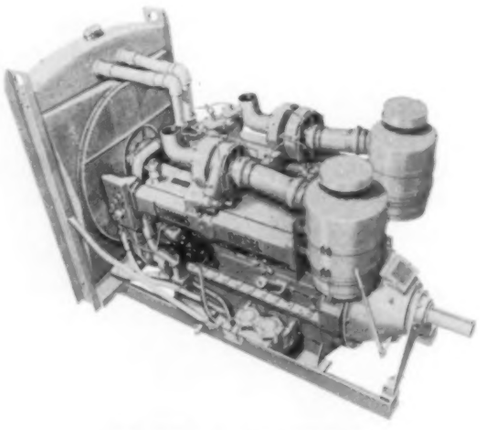
The fuel economy, light weight, heavy-duty design and low maintenance costs are generally considered to be the important factors in the success of Cummins Diesels in automotive service. They are supplied as original equipment in trucks built by Autocar, Crown Body and Coach, Diamond T, Dart, Federal, Four Wheel Drive, Freightliner, Hayes, International Harvester, Kenworth, Mack, Oshkosh, Peterbilt, Reo, Walter, and White. Beck, Fitzjohn, Flxible, and Southern Coach supply Cummins in their buses.



JT-6-B Automotive Turbodiesel Engine.



NRTO-6-BI-Off-highway Engine.



VT-12-IP Industrial Power Unit

CUMMINS INDUSTRIAL DIESELS

Seventy-seven industrial diesel models cover a power range of 60 to 600 horsepower and are available with accessories to adapt them to a wide range of applications. Models with "BI" in the model designation are designed for application in mobile equipment such as earth hauling trucks, scraper units, industrial switching locomotives, portable air compressors, etc. The introduction of Cummins Diesels 400 hp. and over has led to the development of new and larger earth hauling equipment.

Models with "I" in the model designation are industrial engines with mounting feet. This type engine is used for installations in shovels, cranes, logging yarders and loaders, and other applications requiring high horsepower in a limited size. These models can be equipped for either radiator or heat exchanger cooling and are used for marine auxiliaries, pump installations, and other installations requiring heat exchanger cooling. The "IP" models are similar to the "I" models but include radiator and cooling fan. These models are used for powering oil well drilling rigs, shovels, cranes, logging yarders and loaders, and other equipment.

Models with "P" in the designation are power units with hoods for installation out of doors on machinery such as rock crushers, irrigation pumps, sawmills, loaders, cotton gins, etc. where the engine needs some protection from the weather.

Low fuel consumption, low maintenance costs, long life between overhauls, light weight, and portability are important features built into Cummins Industrial Diesels. Operating speeds make these engines adaptable to machinery built to operate at an electrical synchronous speed of 1750 rpm.—such as centrifugal pumps, electric generators, etc.

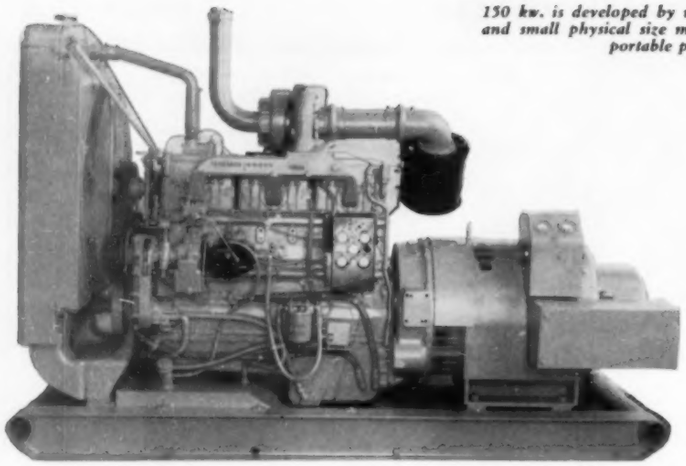
A wide assortment of accessory equipment is available for all of these industrial models to adapt them to individual job requirements. Clutches, torque converters, hydraulic governors, instrument panels, automatic shut-down devices, engine supports, etc. can be supplied to make complete package units. Electric starting equipment normally is supplied but air and gasoline starters also are available.

CUMMINS AUTOMOTIVE DIESELS

Model	Cycle	Cyls.	Bore & Stroke	Displacement	HP.	RPM.	Length	Width	Height	Net Weight
J-6-B	4	6	4 1/8"x5"	401	95	1800	46 9/16	26	42 3/8	1505
JF-6-B	4	6	4 1/8"x5"	401	105	2200	46 9/16	26 1/32	42 3/8	1545
JN-6-B	4	6	4 1/8"x5"	401	125	2500	47 1/4	26 3/8	42 1/2	1555
HRCB-400	4	4	5 1/8"x6"	495	110	1800	43 3/32	30 1/4	47 1/8	1640
NHCB-400	4	4	5 1/8"x6"	495	125	2000	45	28 1/16	47 1/8	1700
JBS-600	4	6	4 1/8"x5"	401	150	2500	47 1/4	25 3/4	40	1600
HB-600	4	6	4 7/8"x6"	672	150	1800	59 1/4	29 3/4	48 3/8	2330
JNS-6-B	4	6	4 1/8"x5"	401	165	2500	47 1/4	26	42 1/2	1610
HRB-600	4	6	5 1/8"x6"	743	165	1800	59 1/4	29 3/4	48 1/8	2330
HHRB-600	4	6	5 1/8"x6"	743	165	1800	65 3/8	60	24	2420
JT-6-B	4	6	4 1/8"x5"	401	175	2500	47 1/4	27 3/4	44 1/4	1615
HRFB-600	4	6	5 1/8"x6"	743	180	2000	60	29 3/4	48 1/8	2385
HHRFB-600	4	6	5 1/8"x6"	743	180	2000	65 3/4	60	24	2420
NHB-600	4	6	5 1/8"x6"	743	210	2100	61 1/4	31 1/4	48 3/4	2465
NHHB-600	4	6	5 1/8"x6"	743	200	2100	65 3/4	60	24	2500
HRBS-600	4	6	5 1/8"x6"	743	225	1800	58 3/32	30 1/4	48 13/32	2605
NT-6-B	4	6	5 1/8"x6"	743	250	2100	61 1/4	38 7/16	48 1/8	2515
NHHT-6-B	4	6	5 1/8"x6"	743	250	2100	65 3/4	67 1/4	22 3/4	2590
NTO-6-B	4	6	5 1/8"x6"	743	262	2100	61 1/4	38 7/16	48 1/8	2515
NHBS-600	4	6	5 1/8"x6"	743	275	2100	60 3/32	34 1/8	48 1/8	2720
NHHRBS-600	4	6	5 1/8"x6"	743	300	2100	65 3/4	61 3/8	22 3/4	2805
NHRBS-600	4	6	5 1/8"x6"	743	300	2100	60 3/32	34 1/8	48 1/8	2725
NRT-6-B	4	6	5 1/8"x6"	743	300	2100	61 1/4	38 7/16	48 1/8	2525
NHHRT-6-B	4	6	5 1/8"x6"	743	300	2100	65 3/4	67 1/4	22 3/4	2605
NRTO-6-B	4	6	5 1/8"x6"	743	335	2100	61 1/4	38 7/16	48 1/8	2525

CUMMINS INDUSTRIAL DIESELS

Model	Cycle	Cyls.	Bore & Stroke	Displacement	Max. HP.	RPM.	Cont. HP.	RPM.	Length	Width	Height	Net Weight
J-4-BI	4	4	4 1/4"x5"	267	60	1800	———	———	34 7/8	24 5/16	44 1/8	990
J-6-BI	4	6	4 1/4"x5"	401	95	1800	71	1800	46 5/8	26	41 1/4	1445
J-6-I	4	6	4 1/4"x5"	401	95	1800	71	1800	47 1/16	29	43 1/2	1633
J-6-IP	4	6	4 1/4"x5"	401	95	1800	71	1800	56 1/2	33	51 3/8	1958
J-6-P	4	6	4 1/4"x5"	401	95	1800	71	1800	72 3/32	33	53 1/8	2298
JF-6-BI	4	6	4 1/4"x5"	401	105	2200	75	2000	46 5/8	26	41 1/4	1485
JF-6-I	4	6	4 1/4"x5"	401	105	2200	75	2000	47 1/16	29	43 1/2	1673
JF-6-IP	4	6	4 1/4"x5"	401	105	2200	75	2000	56 1/2	33	51 3/8	1998
JF-6-P	4	6	4 1/4"x5"	401	105	2200	75	2000	72 3/32	33	53 1/8	2338
JN-6-BI	4	6	4 1/4"x5"	401	125	2500	87	2200	46 5/8	26	42 1/2	1495
JN-6-I	4	6	4 1/4"x5"	401	125	2500	87	2200	47 1/16	28 3/8	43 1/2	1685
JN-6-IP	4	6	4 1/4"x5"	401	125	2500	87	2200	64 3/4	33	51 1/2	2010
JN-6-P	4	6	4 1/4"x5"	401	125	2500	87	2200	72 1/4	33	53 1/8	2350
JBIS-600	4	6	4 1/4"x5"	401	150	2500	105	2200	46 13/32	25 3/4	41 1/4	1540
JIS-600	4	6	4 1/4"x5"	401	150	2500	105	2200	47	27 1/2	40 1/2	1733
JIPS-600	4	6	4 1/4"x5"	401	150	2500	105	2200	56 13/32	33	51 3/8	2058
JPS-600	4	6	4 1/4"x5"	401	150	2500	105	2200	72 3/32	33	54 1/16	2398
JNS-6-BI	4	6	4 1/4"x5"	401	165	2500	115	2200	46 13/32	25 3/4	42 1/2	1550
JNS-6-I	4	6	4 1/4"x5"	401	165	2500	115	2200	47 1/16	28 3/8	43 3/8	1740
JNS-6-IP	4	6	4 1/4"x5"	401	165	2500	115	2200	56 1/2	33	51 3/8	2065
JNS-6-P	4	6	4 1/4"x5"	401	165	2500	115	2200	72 3/32	33	51 1/2	2405
JT-6-BI	4	6	4 1/4"x5"	401	175	2500	121	2200	47	26 1/2	43 3/8	1555
JT-6-I	4	6	4 1/4"x5"	401	175	2500	121	2200	47 1/16	28 3/8	44 3/8	1745
JT-6-IP	4	6	4 1/4"x5"	401	175	2500	121	2200	56 13/32	33	51 3/8	2070
JT-6-P	4	6	4 1/4"x5"	401	175	2500	121	2200	72 3/32	33	51 3/8	2410
HRCBI-400	4	4	5 1/8"x6"	495	110	1800	82	1800	44 3/4	31 1/2	47 3/8	1755
HRCI-400	4	4	5 1/8"x6"	495	110	1800	82	1800	45 3/32	32 1/8	48 3/8	1825
HRCIP-400	4	4	5 1/8"x6"	495	110	1800	82	1800	58	38 3/8	53 7/8	2110
HRCP-400	4	4	5 1/8"x6"	495	110	1800	82	1800	70 1/4	39 3/8	57 3/8	2830
NHCBI-400	4	4	5 1/8"x6"	495	125	2000	90	1800	44 3/8	26 1/2	48 3/8	1815
NHCI-400	4	4	5 1/8"x6"	495	125	2000	90	1800	45 1/8	29	52 3/4	1885
NRCIP-400	4	4	5 1/8"x6"	495	125	2000	90	1800	58	38 3/8	53 7/8	2240
NHCP-400	4	4	5 1/8"x6"	495	125	2000	90	1800	70 1/4	39 3/8	57 3/8	2960
NT-4-BI	4	4	5 1/8"x6"	495	165	2000	117	1800	44 3/8	28 3/4	53	1875
HBI-600	4	6	4 7/8"x6"	672	150	1800	112	1800	58 1/4	30	48 1/4	2270
HI-600	4	6	4 7/8"x6"	672	150	1800	112	1800	61 3/4	30	48 3/8	2543
HIP-600	4	6	4 7/8"x6"	672	150	1800	112	1800	72 1/8	37 1/8	61 3/8	3047
HP-600	4	6	4 7/8"x6"	672	150	1800	112	1800	96 1/8	37 1/8	72 1/4	3525
HRBI-600	4	6	5 1/8"x6"	743	165	1800	123	1800	58 1/4	30	48 1/4	2270
HRI-600	4	6	5 1/8"x6"	743	165	1800	123	1800	61 3/4	30	48 3/8	2543
HRIP-600	4	6	5 1/8"x6"	743	165	1800	123	1800	72 1/8	37 1/8	61 3/8	3047
HRP-600	4	6	5 1/8"x6"	743	165	1800	123	1800	96 1/8	37 1/8	72 1/4	3525
HRFBI-600	4	6	5 1/8"x6"	743	180	2000	128	1800	59 3/8	30	48 3/8	2325
HBIS-600	4	6	4 7/8"x6"	672	200	1800	150	1800	58 3/32	32 1/8	48 11/16	2475
NHBI-600	4	6	4 7/8"x6"	743	210	2100	145	1800	61 3/32	31 3/8	48 1/2	2360
NHI-600	4	6	5 1/8"x6"	743	210	2100	145	1800	62	31 7/8	61 3/8	2646
NHIP-600	4	6	5 1/8"x6"	743	210	2100	145	1800	72 1/8	37 1/8	61 3/8	3152
NHP-600	4	6	5 1/8"x6"	743	210	2100	145	1800	96 1/8	37 1/8	72 1/4	3630
HRBIS-600	4	6	5 1/8"x6"	743	225	1800	168	1800	58 3/32	32 3/8	48 11/16	2485
HRIS-600	4	6	5 1/8"x6"	743	225	1800	168	1800	62	33 1/4	50	2845
HRIPS-600	4	6	5 1/8"x6"	743	225	1800	168	1800	72 1/8	37 1/8	61 3/8	3349
HRPS-600	4	6	5 1/8"x6"	743	225	1800	168	1800	96 1/8	37 1/8	72 1/4	3847
NT-6-BI	4	6	5 1/8"x6"	743	250	2100	172	1800	61 1/8	38 1/2	48 1/2	2455
NT-6-I	4	6	5 1/8"x6"	743	250	2100	172	1800	62	38	52 3/4	2741
NT-6-IP	4	6	5 1/8"x6"	743	250	2100	172	1800	72 1/8	39	61 1/16	3247
NT-6-P	4	6	5 1/8"x6"	743	250	2100	172	1800	98 1/8	39	63 5/8	3725
NTO-6-BI	4	6	5 1/8"x6"	743	262	2100	172	1800	61 1/8	38 1/2	48 1/2	2455
NHBIS-600	4	6	5 1/8"x6"	743	275	2100	183	1800	60 3/32	34 1/8	48 3/8	2660
NHIS-600	4	6	5 1/8"x6"	743	275	2100	183	1800	62	34 1/8	50	3071
NHIPS-600	4	6	5 1/8"x6"	743	275	2100	183	1800	72 1/8	39 3/8	67 3/8	3577
NHPS-600	4	6	5 1/8"x6"	743	275	2100	183	1800	98 1/8	39 3/8	72 1/4	4055
NHRBIS-600	4	6	5 1/8"x6"	743	300	2100	190	1800	60 3/32	34 1/8	48 3/8	2660
NHRIS-600	4	6	5 1/8"x6"	743	300	2100	190	1800	62	34 1/8	50	3071
NHRIPS-600	4	6	5 1/8"x6"	743	300	2100	190	1800	72 1/8	39 3/8	67 3/8	3577
NHRPS-600	4	6	5 1/8"x6"	743	300	2100	190	1800	98 1/8	39 3/8	72 1/4	4055
NRT-6-BI	4	6	5 1/8"x6"	743	300	2100	202	1800	60 3/32	38 3/4	48 1/2	2465
NRT-6-I	4	6	5 1/8"x6"	743	300	2100	202	1800	62	38	52 3/4	2751
NRT-6-IP	4	6	5 1/8"x6"	743	300	2100	202	1800	72 1/8	39 3/8	61 3/8	3257
NRT-6-P	4	6	5 1/8"x6"	743	300	2100	202	1800	98 1/8	39 3/8	63 3/8	3735
NRTO-6-BI	4	6	5 1/8"x6"	743	335	2100	225	1800	60 3/32	38 3/4	48 1/2	2465
NRTO-6-I	4	6	5 1/8"x6"	743	335	2100	225	1800	62	38	52 3/4	2751
NRTO-6-IP	4	6	5 1/8"x6"	743	335	2100	225	1800	72 1/8	39 3/8	61 3/8	3257
NRTO-6-P	4	6	5 1/8"x6"	743	335	2100	225	1800	98 1/8	39 3/8	63 3/8	3735
NVHBI-1200	4	12	5 1/8"x6"	1486	400	2100	280	1800	73 3/8	49 3/8	55 1/2	5150
NVHI-1200	4	12	5 1/8"x6"	1486	400	2100	280	1800	73 3/8	45 1/2	59	5810
VT-12-BI	4	12	5 1/8"x6"	1486	600	2100	430	1800	73 3/8	40 1/4	60 1/16	5610
VT-12-I	4	12	5 1/8"x6"	1486	600	2100	430	1800	73 3/8	45 1/4	65 3/8	6270
LRI-600	4	6	7 1/4"x10"	2477	300	1100	225	1000	99 1/4	39 1/4	58 3/4	7590
LRP-600	4	6	7 1/4"x10"	2477	300	1100	225	1000	136	53 3/8	86 1/8	12000



150 kw. is developed by model NRT-6. Light weight and small physical size makes this an ideal unit for portable power plants.

GENERATOR UNITS

Five standard Cummins generator units of 40 kw, 50 kw, 60 kw, 75 kw, and 100 kw. are available for 60 cycle and 50 cycle alternating current applications. Generators are coupled directly to the engine flywheel and both are mounted on a fabricated steel sub-base. Controls for manual or fully automatic operation are available as optional items. Data for 60 cycle units appears herewith.

60 CYCLE			Set Model	50 CYCLE			Overall Dimensions Including Radiator (Approx.)			Shipping Wgt., Lbs.
Continuous Rating		RPM		Continuous Rating		RPM				
KW	KVA			KW	KVA		L	W	H	
30	37.5	1800	HRC-4-G	25	31.3	1500	86	33	63	3500
40	50	1800	HRC-4-G	33.3	41.6	1500	86	33	63	3800
50	62.5	1800	HRC-4-G	41.6	52	1500	88	33	63	4800
60	75	1800	NHC-4-G	50	62.5	1500	88	33	63	5000
75	93.8	1800	H-6-G	62.5	78	1500	106	33	63	5500
100	125	1800	NH-6-G	83.3	104	1500	109	37	72	6000
125	156	1800	HRS-6-G	104	130	1500	116	40	78	6500
150	187.5	1800	NHRS-6-G	125	156	1500	117	40	78	6800
175	219	1800	NVH-12-G	146	182.5	1500	143	54	84	13000
200	250	1800	NVH-12-G	167	209	1500	143	54	84	13900
250	312	1800	VT-12-G	208	260	1500	145	54	84	14000
300	375	1800	VT-12-G	250	312.5	1500	145	58	89	14800

HORSEPOWER, TORQUE AND FUEL CONSUMPTION

Horsepower and torque curves below and on following pages show performance obtained when operating on No. 2 diesel or furnace oil. Equivalent results can be obtained with lighter No. 1 fuels or heavier No. 3 fuels by a simple adjustment and recalibration of the fuel pump.

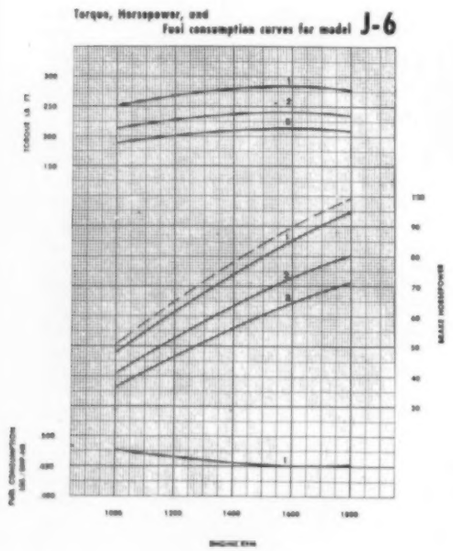
Broken line represents maximum brake horsepower corrected to conditions of 29.92 inches of mercury barometer pressure and 60° Fahrenheit intake air temperature. Curve No. 1 represents horsepower available at normal operating conditions of 28.82 inches of mercury (1000 ft. autitude) barometric pressure and 90° Fahrenheit intake air temperature. Unless otherwise specified, fuel pumps are set to deliver this power. This rating is suggested for use in on-highway trucks, buses, off-highway trucks, scrapers, tractors, cranes, shovels, and similar applications.

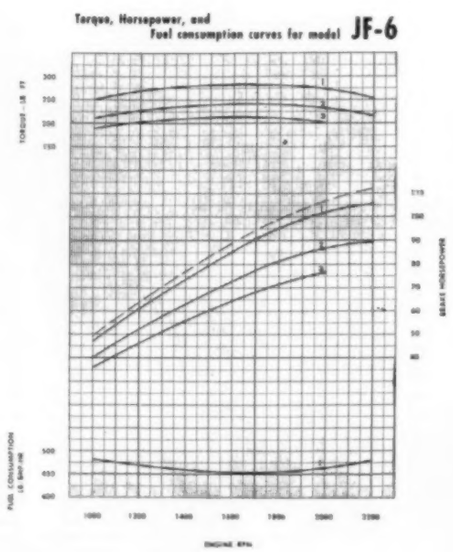
Curve No. 2 is a suggested rating for intermittent applications such as sawmills, rock crushers, electric generator sets for standby or seasonal applications, or other applications in which periods of operation at full load are followed by equal periods of operation at partial load or shutdown.

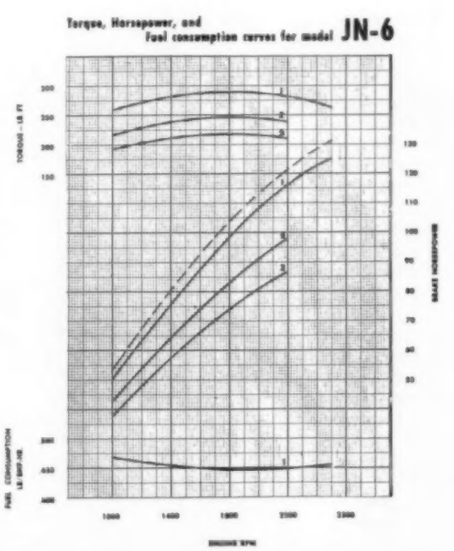
Curve No. 3 is a suggested rating for continuous duty service in which full power is required for long periods of time without equal intervals of operation at reduced loads or shut-down.

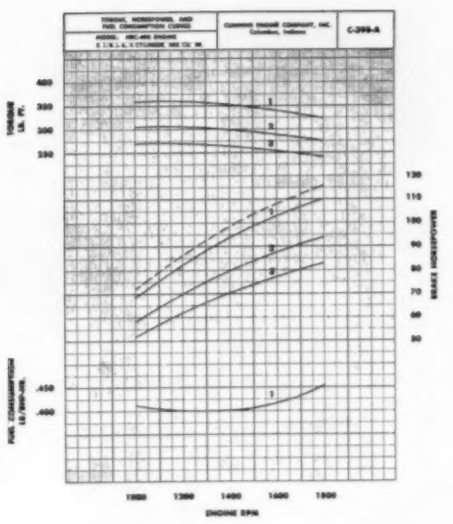
Horsepower and torque curves represent gross power available with all auxiliary equipment except battery charging generator, compressor, fan and optional equipment. Fuel consumption curve represents the fuel rate when engine is developing maximum power. Two ratings are available for VT-12 Turbodiesels due to different turbocharger settings. A different turbo setting provides more power at speed up to 1800 rpm from VT-12. This turbo setting allows 575 hp to be developed at 1800 rpm, compared to 600 hp at 2100 rpm for the standard turbo setting.

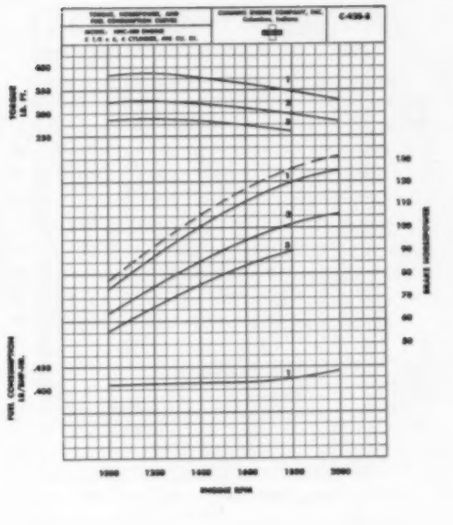
All Cummins diesels are tested on dynomometers and engines must conform with published curve before shipment is authorized.

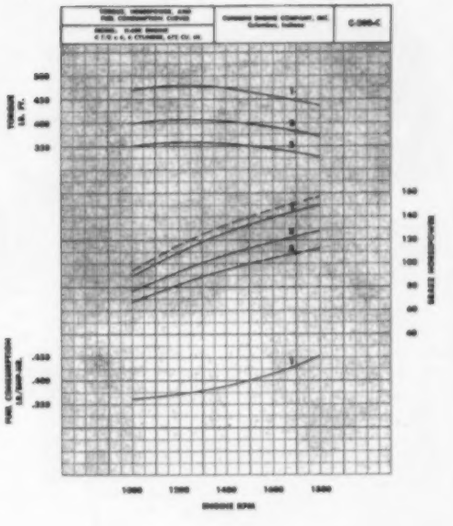


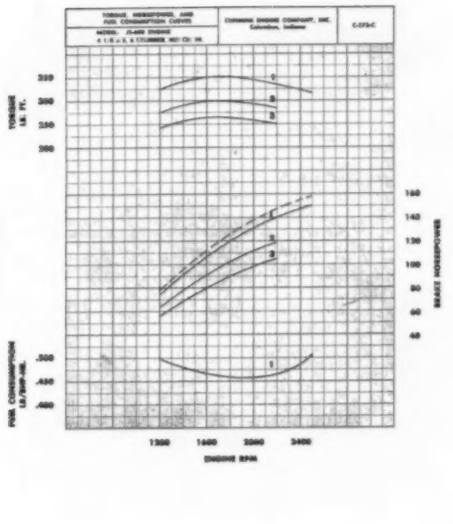


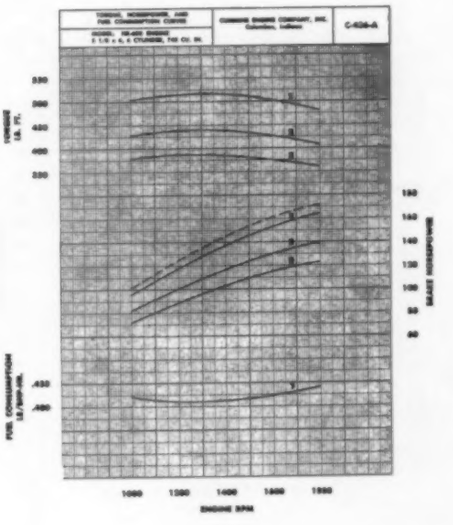


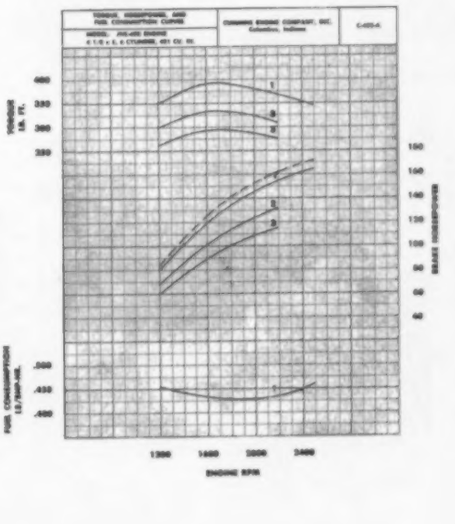


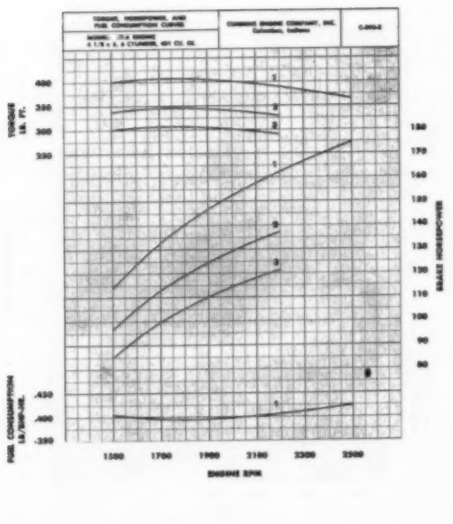


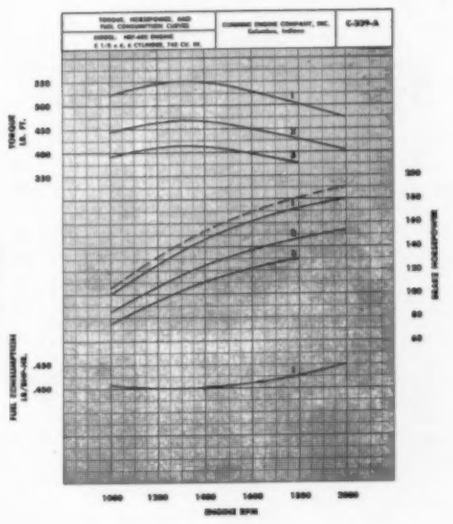


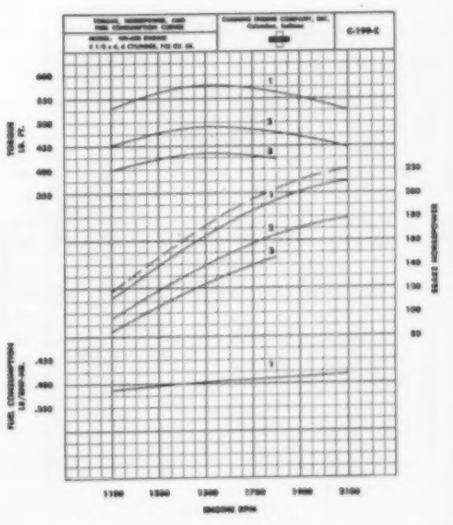


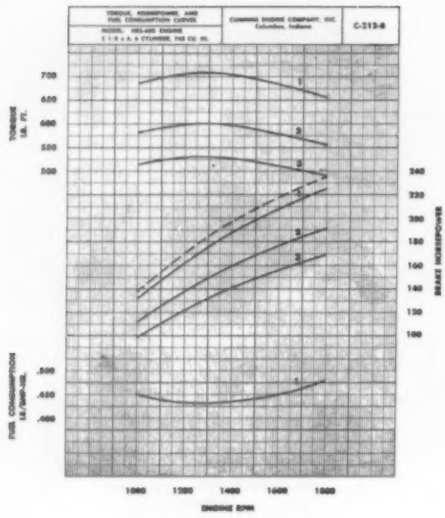


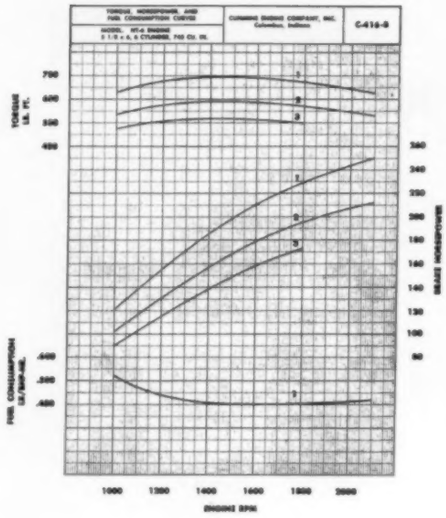


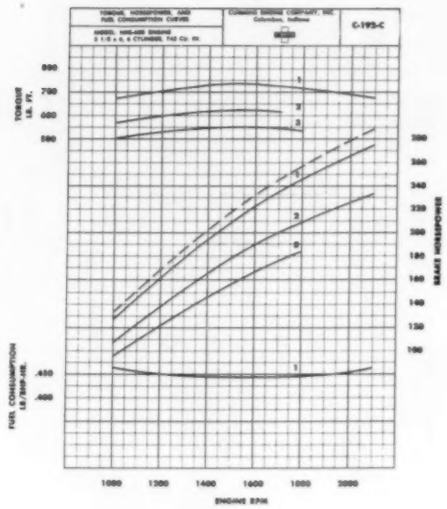


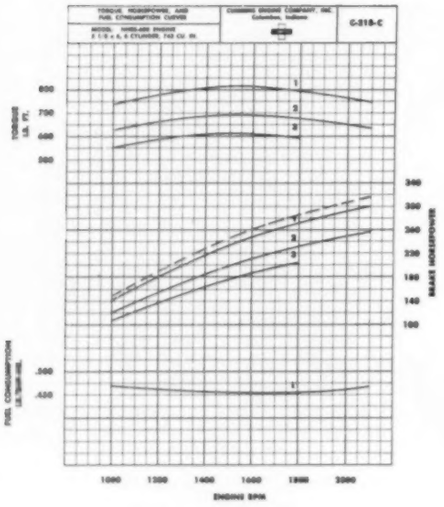


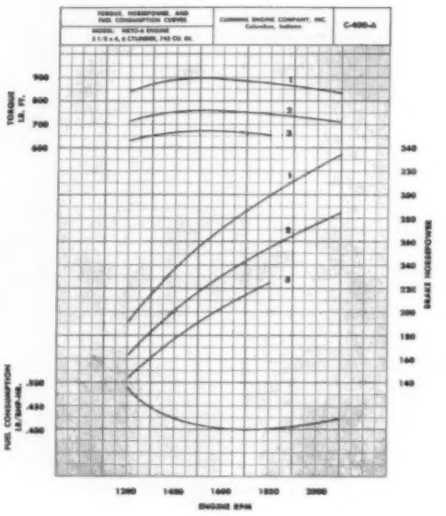


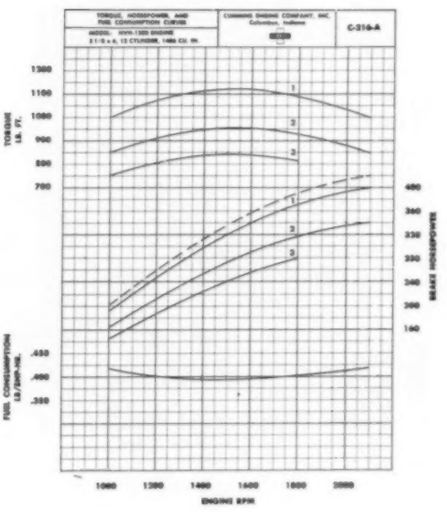


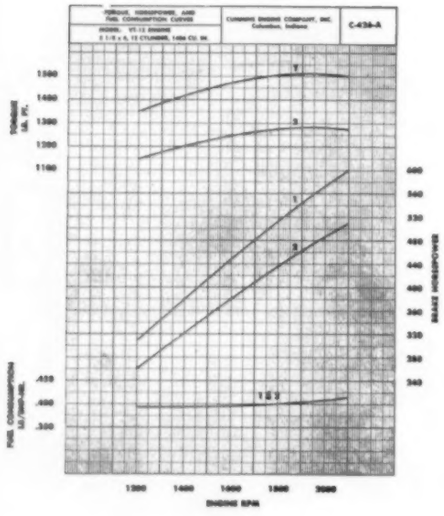


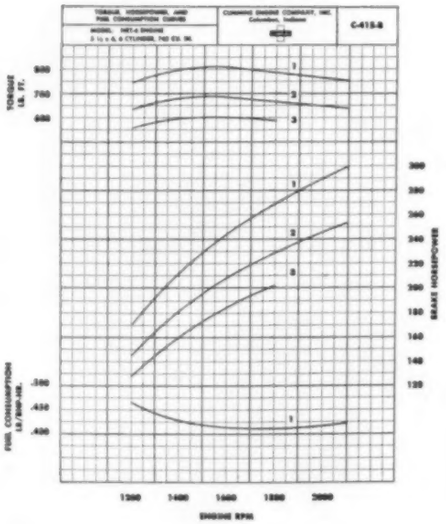


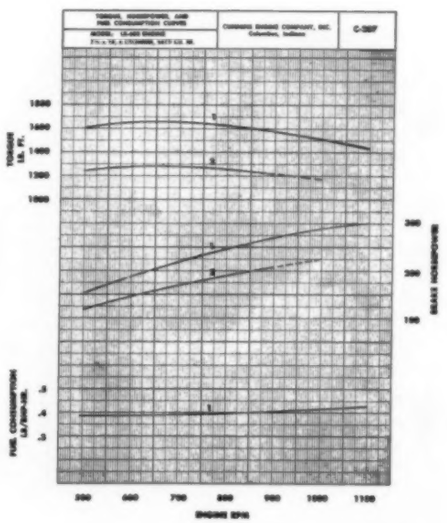










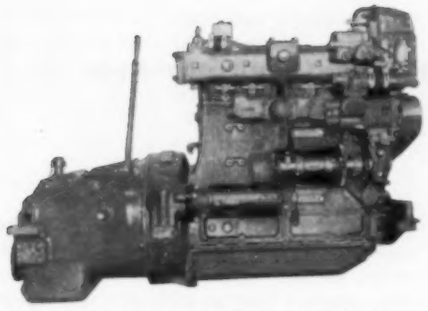


CUMMINS MARINE DIESELS

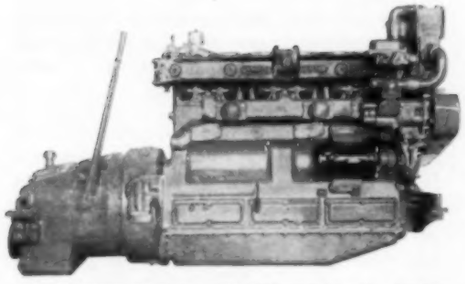
Nineteen powerful, compact marine Diesel engines are designed and built by Cummins. These engines are mostly used for the tough, heavy-duty work boats such as commercial fishing boats, river tow boats, logging, tugs, dredges, ferries, shrimp boats, etc. where dependability and low operating costs are important considerations. They also are installed in police boats, pleasure boats, off-shore oil well personnel boats, and similar installations where high speeds are required.

Various reverse and reduction gears are available to give propeller speeds necessary for different types of service in the 60 to 600 hp. range. All units are equipped with heat exchangers to permit use of sea water for cooling. Front power take-off arrangements can be provided for operating winches. Intake air silencers are provided as standard on most models but air cleaners can be provided. Hydraulic governors, alarm systems for high water temperature and low oil pressure, instrument panels and other accessories are available.

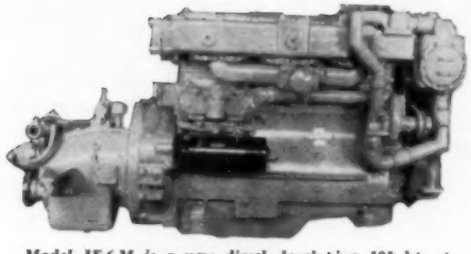
The compactness of Cummins Diesels allows the boat builder to install more power in a smaller engine room and permits greater utilization of below deck space for cargo.



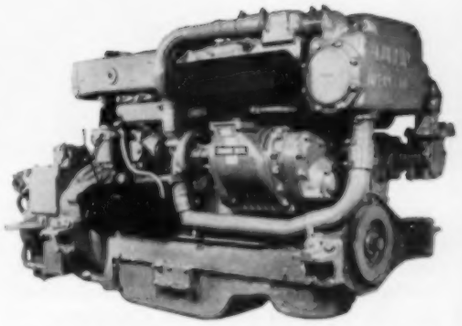
Model HRCM-400 is a 4 cylinder model which is rated 110 hp. at 1800 rpm.



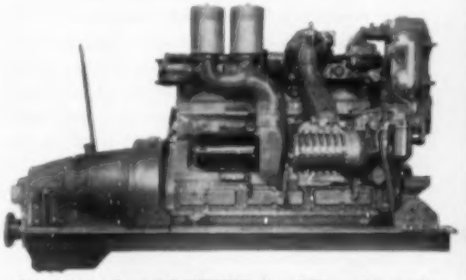
Model HRM-600 is a 6 cylinder model which develops 165 hp. at 1800 rpm.



Model JF-6-M is a new diesel developing 105 hp at 2200 rpm.

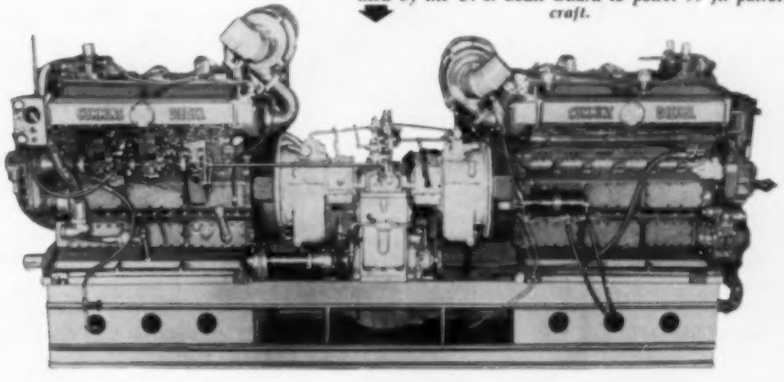


Model JMS-600, is a new light weight marine engine developing 140 hp. for pleasure boats and 123 hp. for work boat applications.



Supercharged model NHRMS is a 743 cu. in. engine which develops 300 hp. at 2100 rpm.

1200 hp. on a single shaft is developed by model VT-12-Tandem. Two of these units per vessel are being used by the U. S. Coast Guard to power 95 ft. patrol craft.



CUMMINS MARINE DIESELS

Model	Cycle	Cyls.	Bore & Stroke	Maximum HP.	RPM.	Continuous HP.	RPM.	Length	Width	Height	Net Weight
J-6-M	4	6	4 1/8"x5"	95	1800	66	1600	69	27 1/16	35 1/4	1645
JF-6-M	4	6	4 1/8"x5"	105	2200	73	1950	69	27 1/16	35 1/4	1645
JN-6-M	4	6	4 1/8"x5"	125	2200	86	2200	69	27 1/16	35 1/4	1645
HRCM-400	4	4	5 1/8"x6"	110	1800	78	1600	66 7/8	30 1/8	45 1/2	1715
NHCM-600	4	4	5 1/8"x6"	120	1800	84	1600	66 7/8	30 1/8	45 1/2	1760
JMS-600	4	6	4 1/8"x5"	150	2500	101	2200	69	27 1/16	35 1/4	1990
HM-600	4	6	4 7/8"x6"	150	1800	103	1600	80 7/8	30 1/8	45 1/2	2490
HRM-600	4	6	5 1/8"x6"	165	1800	115	1600	80 7/8	30 1/8	45 1/2	2495
JNS-6-M	4	6	4 1/8"x5"	165	2500	111	2200				
JT-6-M	4	6	4 1/8"x5"	175	2500	119	2200	69	34 1/16	44 1/4	1850
NHM-600	4	6	5 1/8"x6"	200	2100	126	1800	83 1/8	28	48 1/4	2625
HRMS-600	4	6	5 1/8"x6"	225	1800	159	1600	80 1/2	31 3/4	48 1/4	2700
NT-6-M	4	6	5 1/8"x6"	250	2100	165	1600	83 1/8	38 3/16	48 3/16	2725
NHMS-600	4	6	5 1/8"x6"	275	2100	184	1850	83 1/8	32	48 1/4	2955
NHRMS-600	4	6	5 1/8"x6"	300	2100	186	1850	83 1/8	32	48 1/4	2955
NRT-6-M	4	6	5 1/8"x6"	300	2100	201	1800	83 1/8	38 3/16	48 3/16	2725
NRTO-6-M	4	6	5 1/8"x6"	335	2100	225	1800	83 1/8	38 3/16	48 3/16	2725
NVHM-1200	4	12	5 1/8"x6"	400	2100	272	1850	110	41	55 1/2	4500
VT-12-M	4	12	5 1/8"x6"	600	2100	425	1850	110	42	55 1/2	4750
LRM-600	4	6	7 1/4"x10"	300	1100	230	1000	144 1/4	43 3/4	58 1/2	9240

WITTE

Diesel Power Units and Engine-Generator Sets

IN addition to the usual applications for small diesel engine drive, such as pumps, compressors, light plants, blowers, stationary farm and mining machinery, Witte Engine Works, Oil Well Supply Division of United States Steel Corporation has designed and engineered its line of diesels to the requirements of rapidly opening new fields.

All of the various WITTE models are the end-product of experience and research, always motivated more by the needs of the industrial rather than the automotive field. The primary objective has always been an engine which would not be subject to excessive wear or high maintenance costs but could be counted upon to deliver its full rated output around the clock.

This feature has always been important to a prospective customer looking for a reliable unit. In the field of communications, particularly microwave transmission, a costly power failure of as short a duration as a few minutes can be avoided with a unit embodying Witte quality. It has been realized that the small diesel, driving a dependable generator and equipped with reliable controls, is the answer to the necessity for power where it is needed, when it is needed. Isolated locations no longer present a problem; unattended installations, inspected only every 30 days, have been reported as very successful. In addition to the already mentioned applications of this type of control in the microwave and radio fields, there are many institutions or businesses that cannot afford a power failure; theatres, hatcheries, hospitals, and freezer plants, to name just a few.

Witte Engine Works has recently announced the release of a new Series "100" diesel engine which incorporates a very modern compact design and balanced construction. This horizontally opposed two cylinder engine is readily adaptable to applications previously restricted by the lack of head room or by the lack of adequate means of support. The Witte "100" runs smoothly under full load without holddown means, and is only 25¼" high.

POWER UNITS

All WITTE diesel engines are of the 4 stroke cycle, water-cooled, heavy-duty type. The single cylinder, horizontal or vertical models are in the medium speed range and develop from 4 to 12.5 horsepower for continuous 24-hour-a-day service. The new two cylinder horizontally opposed diesel engine develops 18 continuous horsepower at 1800 rpm. It is intended for continuous, 24-hour-a-day service in heavy-duty industrial applications, or variable load, constant speed application. For such applications it can be obtained with or without clutch power take-off.

SERIES "100"—TWO CYLINDER DIESEL: This modern engine incorporates a one-piece cast iron cylinder block and crankcase of a compact, box-like structure which imparts unusual sturdiness and stability to the power unit. Support pads of ample size are spaced far apart and only 6⅞" below the crankshaft centerline, close to the center of the engine mass. Bare engine dimensions are: Length 28-⅝", width 39", height25¼"; weight is 700 lbs (dry).

The horizontally opposed piston design results in a balanced construction that has practically eliminated vibration. The engine operates smoothly under full load without holddown means. These features assure positive engine anchorage and freedom from vibration for all types of portable and stationary power unit applications. This includes a wide variety of applications previously considered to be outside the scope of small diesel engines.

Other design features include a dynamically balanced, forged steel crankshaft, full pressure lubrication, wet-type replaceable cylinder liners, precision aluminum bearings, replaceable valve guides and valve-seat inserts, and parts interchangeability between cylinders.

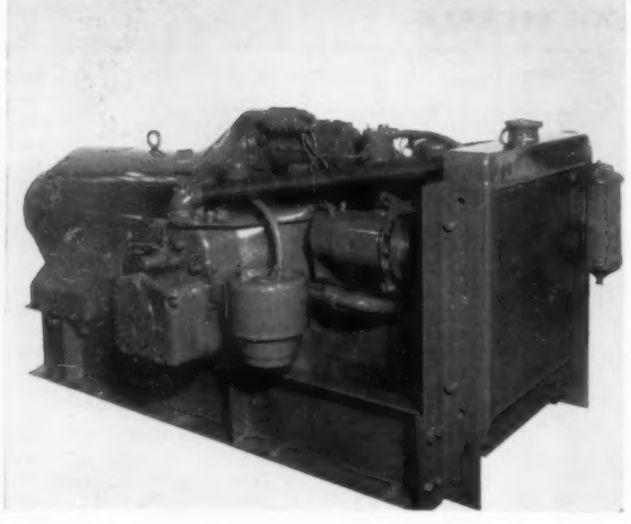
SERIES "AD", "BD", AND "CD"—SINGLE CYLINDER DIESELS: Crankcase and cylinder block are made of cast iron and are of simple, sturdy design. The cast-iron base incorporates an oil sump and, in belt-driven engine-generator sets, extends to accommodate the generator. The cylinder block is provided with a replaceable wet-type cylinder liner of alloyed iron.

The counterbalanced crankshaft, manufactured from a drop-forged and mounted in tapered-roller bearings, incorporates tapered mounting surfaces for flywheel and/or power take-off adapters, such as clutch or stubshaft. Connecting rod is a machined steel drop-forging. Its crank-end is fitted with bearing inserts and the piston pin rests in a bronze bushing. The piston uses four compression rings and an oil-control ring.

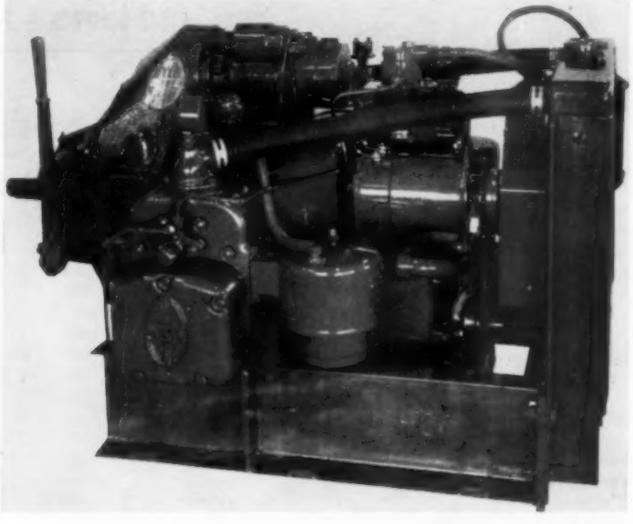
Both the inlet and exhaust valve and the valve-seat inserts are of special steel alloy and receive ample cooling through the water passages in the cast-iron cylinder head. The precombustion chamber consists of a turbulence chamber of the air-cell type. The complete valve actuating mechanism is fully enclosed and receives positive lubrication. Camshaft is hardened and precision ground with the cams and gear integral with shaft, assuring accurate timing.

The output of the fuel-injection pump is controlled by a sensitive fly-ball type governor, maintaining the engine speed variations within ± 3%. The

Model "100RDA"



Model "100RC"



vertical models are full-pressure lubricated, while the horizontal units obtain their lubrication from a combination splash-pressure system. A thermo-syphon system, employing radiator or tank, cools the vertical models. The horizontal models are equipped with a modified vapor-phase condenser.

ENGINE-GENERATOR SETS

All generators are rated at 0.8 power factor to allow ample capacity for inductive loads, such as electric motors. A standard drip-proof frame is used, and the rotor is dyamically balanced. The generators meet all underwriters and N.E.M.A. specifications.

SERIES "100": The WITTE model 100RDA diesel engine-generator set consists of the Series "100" two cylinder diesel engine, described above, direct-connected to a single bearing, revolving field-type generator. The generator is housed in a drip-proof frame with a direct-connected exciter, circuit breakers, and an enclosed voltage regulator.

The generator and engine are mounted on a common structural steel base forming a compact, sturdy, and exceptionally smooth operating unit. The model 100RDA is available in either single or three phase, alternating current, 60 cycle, 115/230 or 120/208 voltage, and is rated 12 KW, 15 KVA, for continuous duty.

SERIES "AD", "BD", AND "CD": Either direct-connected or belt-driven, WITTE single cylinder diesel engine-generator sets are available for all standard voltages, frequencies, and phases. The generator is a packaged unit, consisting of a revolving field alternator, direct-connected exciter and frame-mounted "resonant-circuit" type voltage regulator. This type of regulator, capable of keeping the voltage within ± 3% has the decided advantage of using no vibrating contacts.

CONTROLS

The control equipment available with WITTE units falls basically into the following categories:

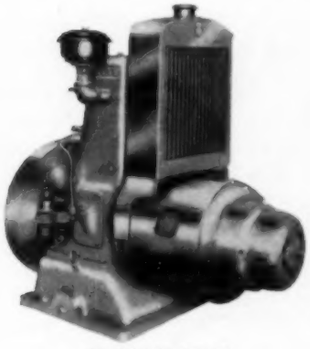
1. Electric start
2. Push-button-remote control
3. Safety controls (high water temperature, low oil pressure, and overspeed shutdown devices)
4. Cranking-control panel
5. Power-failure panel
6. Power-demand panel

(A 12-volt electric starting system and electrical safety controls are furnished as standard equipment on the Series "100")

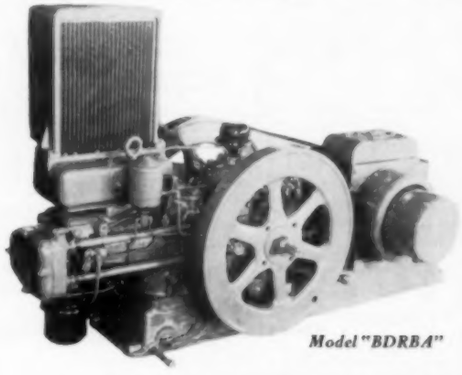
Series	No. of Cyl.	Bore in.	Stroke in.	Dis-place-ment cu. in.	Speed rpm	HP Cont.	HP Max.	KW Rating Cont.	KW Rating Max.
AD•	1	3¼	4½	37.3	1200	4	4.8	2.4	3
BD†	1	4¼	6	85	900	8	10.2	5	6.1
CD†	1	5	8	157	750	12.5	15.6	8	9.5
100†	2	4	4	100.5	1800	18	24	12	14.5

• Vertical † Horizontal

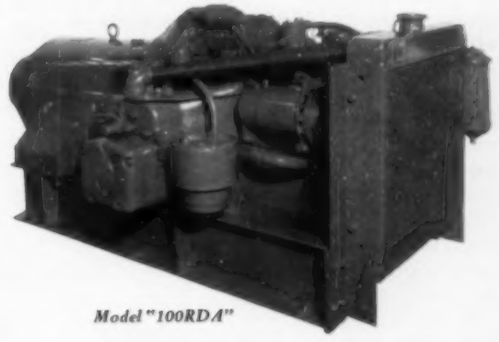
Witte Diesel Engine-Generator Units



Model "ADRDA"



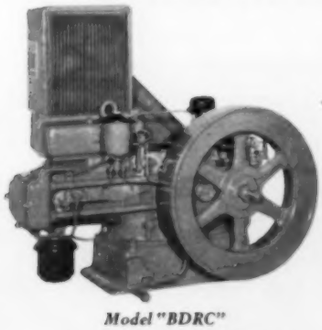
Model "BDRBA"



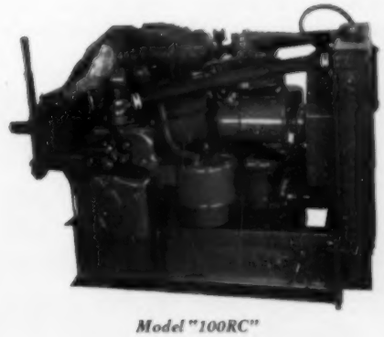
Model "100RDA"

Witte Diesel Power Units

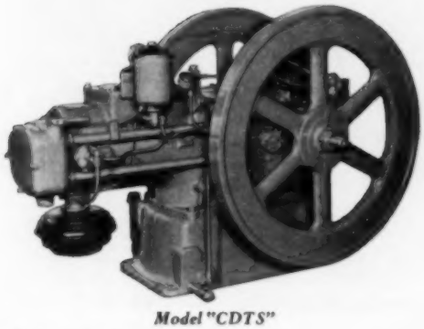
Model "ADRC"



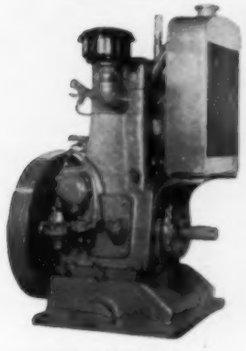
Model "BDRC"



Model "100RC"



Model "CDTS"



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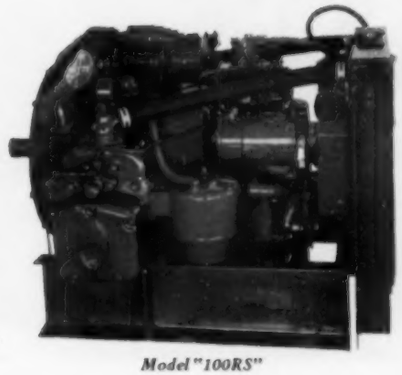


Model "100RS"

COOPER-BESSEMER

MARINE, STATIONARY
LOCOMOTIVE
FOUR CYCLE

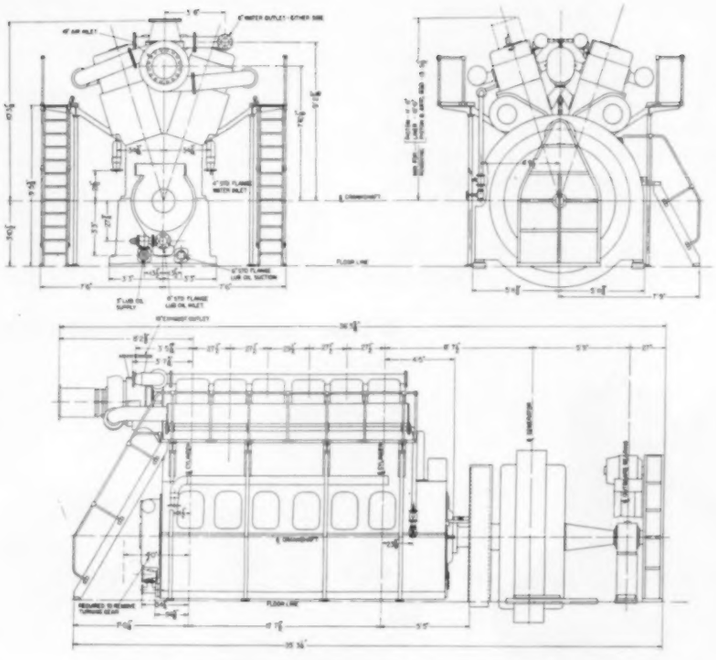
COOPER-BESSEMER diesels are built in four cylinder sizes, each cylinder size in several different numbers of cylinders per unit. Most of the models can be supplied turbocharged as well as naturally aspirated, and the result is a wide range of power available with a wide choice of engines to suit variations in installation requirements. All of the models are applicable to stationary service, including industrial applications. Nearly all of them are used for marine service. All engines are of the four-cycle type. All except one cylinder size are also available as gas-diesel (dual fuel) or supercharged gas engines.

Stationary engines in naturally aspirated models range from the six cylinder 515 hp. at 450 rpm. unit to the 16 cylinder 2565 hp. at 360 rpm. unit to include a total of 23 models. In addition, there are 20 turbocharged models the largest of which has a top rating of 5450 hp. at 360 rpm., with air inlet coolers.

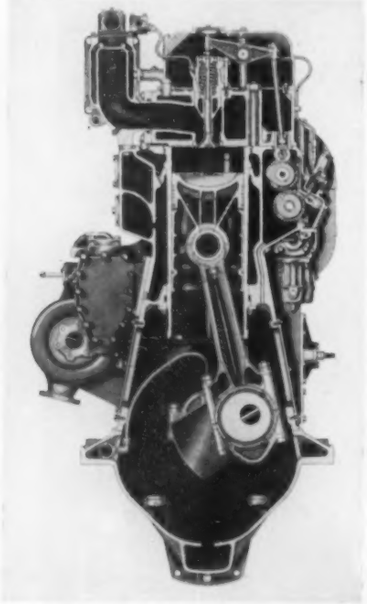
Marine engines range from 250 hp. at 1000 rpm. in six cylinders to 2565 hp. at 360 rpm. in 16 cylinders, naturally aspirated, and up to 5450 hp. at 360 rpm. turbocharged.

There are four locomotive models from 430 hp. to the sixteen cylinder V-type turbocharged 3120 hp. unit.

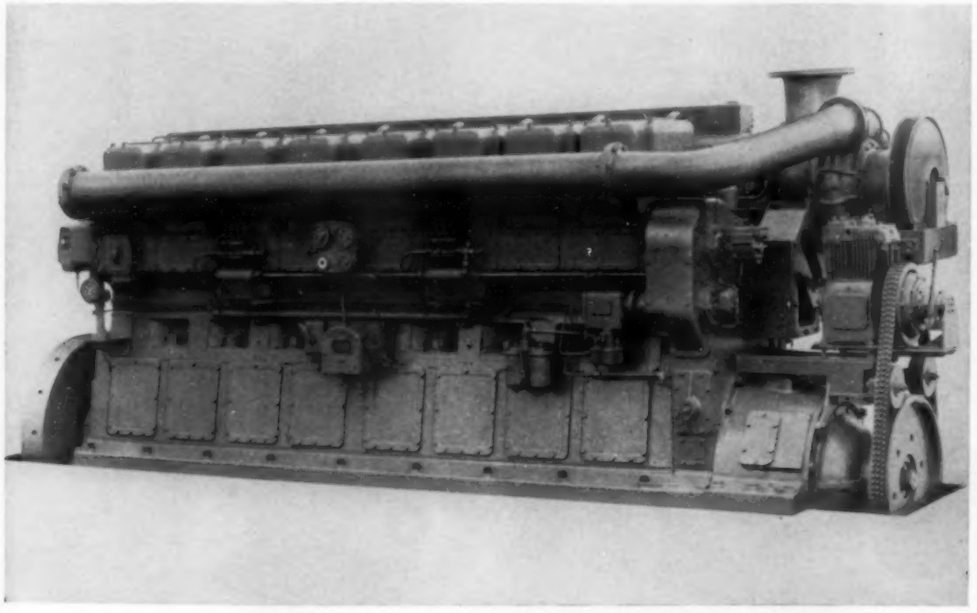
The tabulation at the end of this article lists all of the models and sizes. While there are variations in details the general design of all of the models is similar, except the FW and FVBL engines.



Space Plan LSV-16-T engine direct connected to A.C. generator.



Cross section of Type JS Marine Diesel.



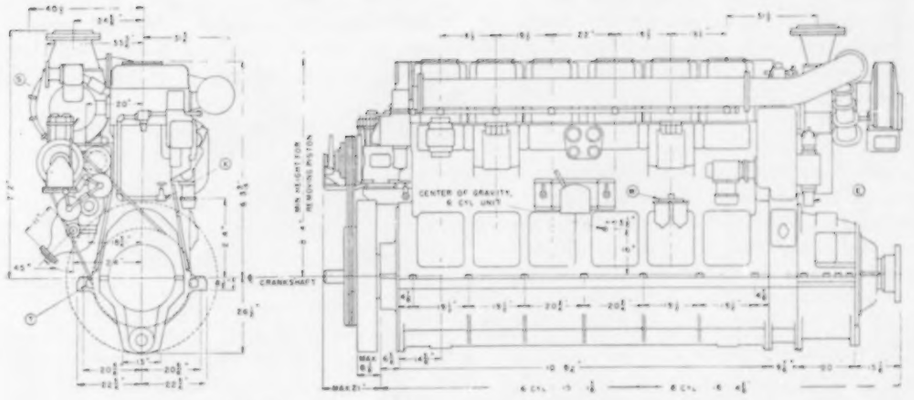
Type JS supercharged 8-cylinder direct reversing marine Diesel.

BASE AND FRAME follow one of two constructions. The Types GS, JS and LS have the base cast separate with the center frame and cylinder block as one piece. The type LSV has the base and center frame separate and two cylinder blocks. All castings are of special alloy iron, well designed for strength and rigidity with a minimum of weight. All bases are of the drop pan type (except the LS and LSV) with a trough underneath to drain the lubricating oil to the separate sump tank. Flanges along the sides with bosses provide for bolting to the foundation.

Large crankcase doors on both sides give good access to the bearings and other parts. Cylinder blocks provide good jacket space and good cooling to the separate wet type cylinder liners.

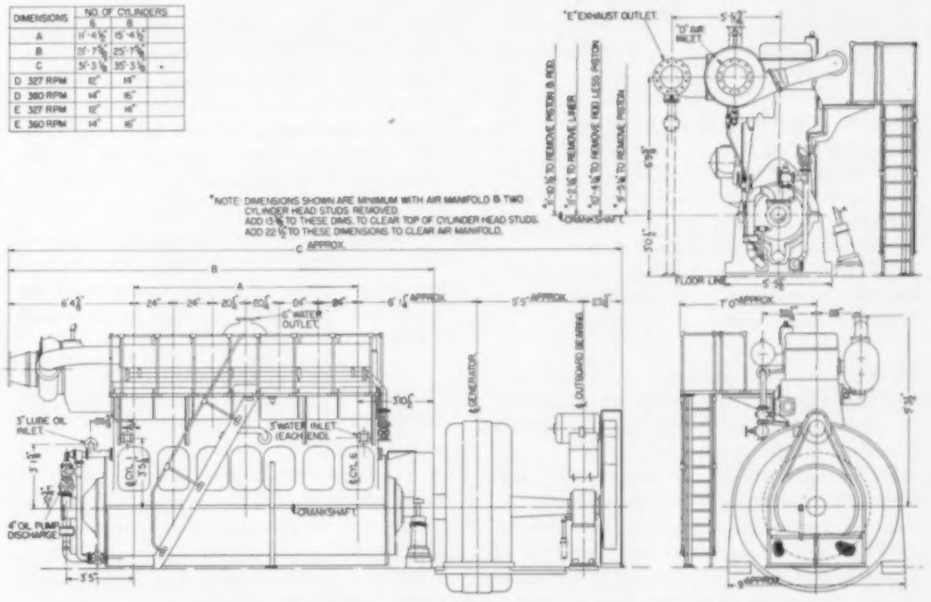
CYLINDER LINERS are of wet type and removable in all cases. They are of special alloy iron, machined all over, and carefully honed inside. In the GS models, the liner is bolted to the cylinder head, and the water joints top and bottom are made tight by rubber seal rings. The liner can be easily removed from the block at any time by simply lifting it out with the head, or the head can be removed independently without disturbing the liner. In the JS and LS models, the liner is held in place by the head but not bolted to it. The upper end of the liner rests against a shoulder down from the top to avoid heavy sections of metal at the hottest part of the liner and to provide good cooling for the liner and the block at this upper end. Water joints at the top and bottom are sealed by rubber rings, and the lower rings may be adjusted or replaced through the crankcase doors if necessary.

CRANKSHAFT is made from a one piece steel forging. All FW and FVBL shafts are hardened and ground with integral counterweights. Shaft pro-



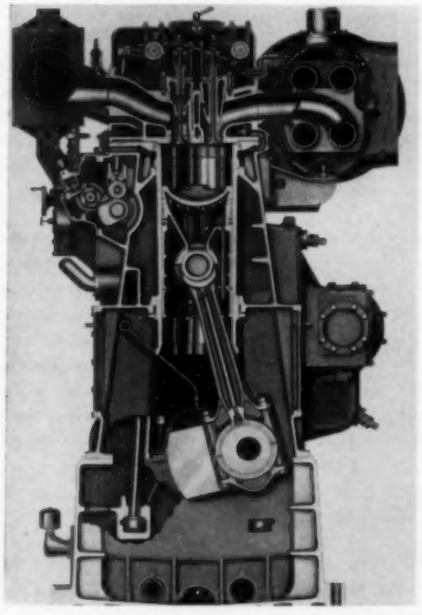
Dimensional drawing of Type JS supercharged-direct reversing marine Diesel.

DIMENSIONS	NO. OF CYLINDERS	
	6	8
A	11'-4 5/8"	15'-4 5/8"
B	21'-7 3/8"	25'-7 3/8"
C	31'-3 1/8"	35'-3 1/8"
D 327 RPM	12"	14"
D 360 RPM	14"	15"
E 327 RPM	12"	14"
E 360 RPM	14"	15"

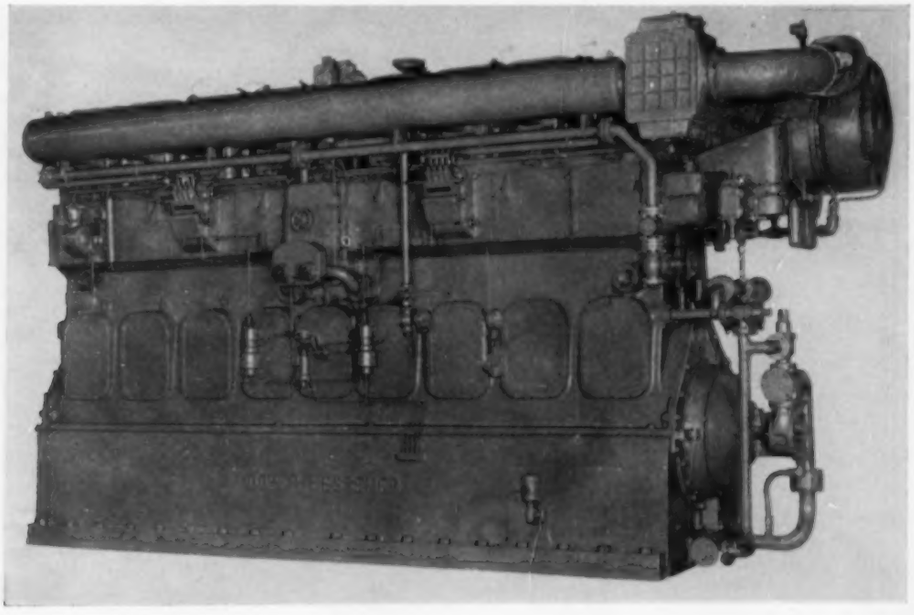


Dimensional drawing Cooper-Bessemer Type LS turbocharged stationary engine.

Cooper-Bessemer LS cross-sectional view.



Type LS supercharged 8 cylinder stationary Diesel.



portions are generous and more than meet all requirements of Lloyd's and American Bureau of Shipping for marine work. Crankshafts are drilled to carry lubricating oil from the main bearings to the crankpin bearings.

MAIN BEARINGS are split babbitt-lined precision shells with shims (except GS) for adjustment. They are firmly held in place by the main bearing caps which are set into the base to provide a shoulder on either side. The end bearing next to the flywheel is extra long. In the LS engines, the drive for the camshaft is at mid-engine length and there are two main bearings, one either side of the chain sprocket on the crankshaft.

CONNECTING RODS are die-forged of high carbon steel with I-section bodies which are drilled their length to carry the lubricating oil from the crankpin up to the piston pin. Crankpin bearings are precision shells with shims (except GS) for adjustment. They are held by the forged steel caps and the alloy steel bolts. Upper ends of rods are machined to provide a saddle for the piston pin, which is bolted to the rod. Piston pin is of steel, bored hollow, case hardened and ground. This construction is patented and provides the largest bearing surface on the upper side of the piston pin for the gas loads. Piston pin bearings are bronze bushings in the piston, so shaped as to provide an all-around bearing surface at the ends in order to take care of the inertia loads.

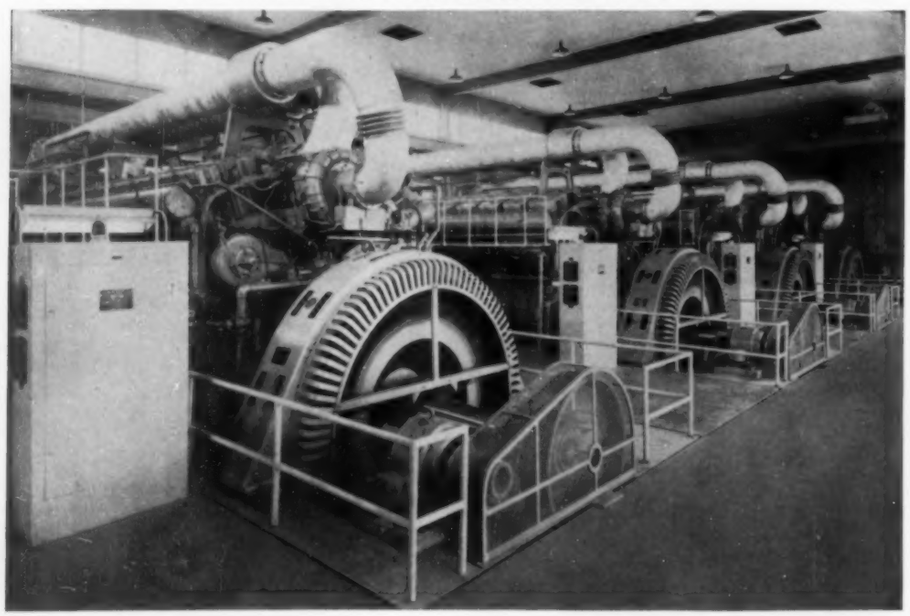
PISTONS are made of specially processed alloy cast iron. The engine pistons are oil cooled. The oil circulates from the piston pin bearing into a cooling chamber formed in the piston under the crown and behind the compression piston rings. This cooling helps to hold pistons to dimensions during operation, it tends to prevent warping, and it helps to prevent formation of carbon behind the piston rings and on the upper piston. The cooling oil overflow from the cooling chamber is through drilled holes in the piston and back to the crankcase. The usual compression rings and oil control rings are fitted according to the requirements of each model.

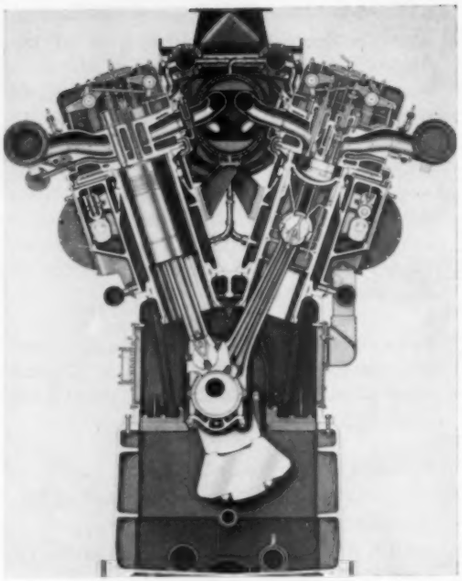
CYLINDER HEADS are individual castings of special cast iron and held to the top of the cylinder block by studs. The fuel injector is in the center of the head in all cases. Some engine models have single inlet and exhaust valves, and others, especially the turbocharged units, have two inlet and two exhaust valves. In most models, the valves seat directly in the heads, with special alloy inserts for the exhaust valve seats. The LS and LSV engines have separate water-cooled exhaust valve cages, and the full flow of water through the engine passes from the cylinder heads through the valve cages and on to the exhaust header jacket.

Valves are of special heat-resisting construction, and the stems operate in renewable cast iron guides. Each cylinder head has its air starting valve set into the head in a separate cage, except in the smaller sizes. In addition to carrying all of these valves, the cylinder heads provide passages with generous flow areas for inlet air and exhaust gases with connections to the respective headers, provision for enclosing the valves and valve gear, and good water cooling to insure even temperatures of all portions. On top of the heads are covers which are easily removed for inspection purposes.

CAMSHAFT is mounted in a trough enclosure on the side of the cylinder block near the top of it. In all models, the camshaft is steel and the cams are made separately, hardened, lubrited, and keyed to shaft. Reversible marine engines have two sets of cams, one for ahead and one for astern motion. The camshaft is driven from the crankshaft by a roller type chain and gears. The FW, FVB and GSVA are gear-driven.

Four Type LSV-16 turbocharged Gas-Diesel engines in the M & A Electric Power Cooperative's Poplar Bluff, Missouri Plant. This plant won the award for being 1954's and 1956's most efficient R.E.A. Cooperative generating plant in the country.





Cooper Bessemer LSV diesel cross-sectional view.

VALVE GEAR consists of cam followers, short push rods, and rockers which act directly on the ends of the valve stems. The rockers are supported by the stanchions bolted to the top of the cylinder heads. On four-valve heads, the valves on the side of the head away from the camshaft are operated from the near-side valve rockers by cross push rods and right-angle rockers. All of this valve gear is accessible by lifting off the top cylinder head cover.

FUEL INJECTION for the FVBL, FW and GSVA engines is by impulse pumps. Individual pumps are used and they are mounted on top of the cylinder heads above the camshaft from which they are actuated by short push rods. Short tubes of equal length for all cylinders connect each pump with its fuel injector in the center of the head. These pumps are all controlled by a shaft running along the front of the engine to the governor at the end. Pumps are supplied by a header which is filled through a filter from the engine driven rotary gear type transfer pump.

Fuel injection for all other models is by the Cooper-Bessemer Pressure Relief system. The diagrammatic arrangement of it is shown here. It includes a duplex fuel pressure pump, with hardened and lapped plungers, which is operated by an auxiliary shaft adjacent to the chain drive.

The fuel pump incorporates a rotary sleeve valve at the suction inlet which allows the pump to pressure only enough fuel oil to take care of injection demands. Fuel control is thus on the low pressure side, reducing maintenance and leakage. Fuel from the high pressure header flows to the metering valves, one for each cylinder, which are grouped in blocks of three for six cylinder engines and blocks of four for eight cylinder engines. These blocks are, as shown, bolted to the outside of the camshaft housing where they are readily accessible.

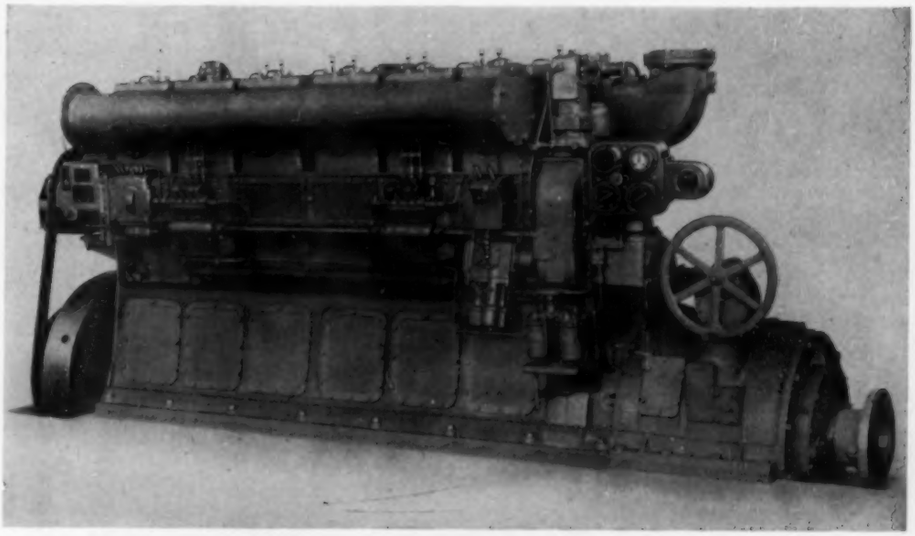
Metering valves are adjusted at the factory for proper balance of load among cylinders, and this

adjustment is not disturbed in any way by the removal of the cylinder head or of the fuel line leading to the nozzle. The function of the metering valves is to control the flow of fuel to the injection nozzles. Cam-operated plungers raise the valves, allowing fuel under high pressure to flow past the valves into the tubing leading to the nozzles. Since the nozzle valve in the fuel injector is spring-loaded to open at a pressure below that maintained by the high pressure pump, fuel is sprayed into the cylinder until the metering valve is allowed to close. The length of time the valves are held open, controlled by a lever which varies the effectiveness of the metering valve cam and the pressure existing at the time, determine the amount of fuel sprayed into the cylinder. This method of regulating fuel flow gives excellent control over an engine's entire range of speed and load.

Immediately following each injection period, the pressure in the injection tubing is lowered below that necessary to open the spring-loaded nozzle valve. This atmospheric relief prevents a possible secondary injection of fuel caused by pressure waves building up in the injection tubing.

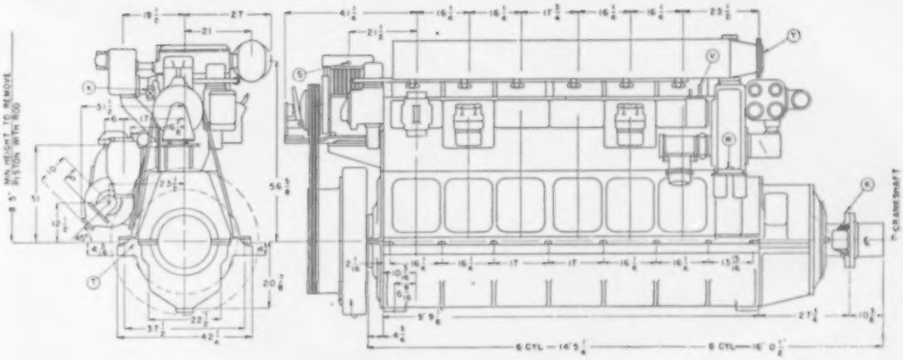
All Cooper-Bessemer Diesels have open type combustion chambers formed in the space between the flat underside of the cylinder head and the concave cavity in the top of the piston.

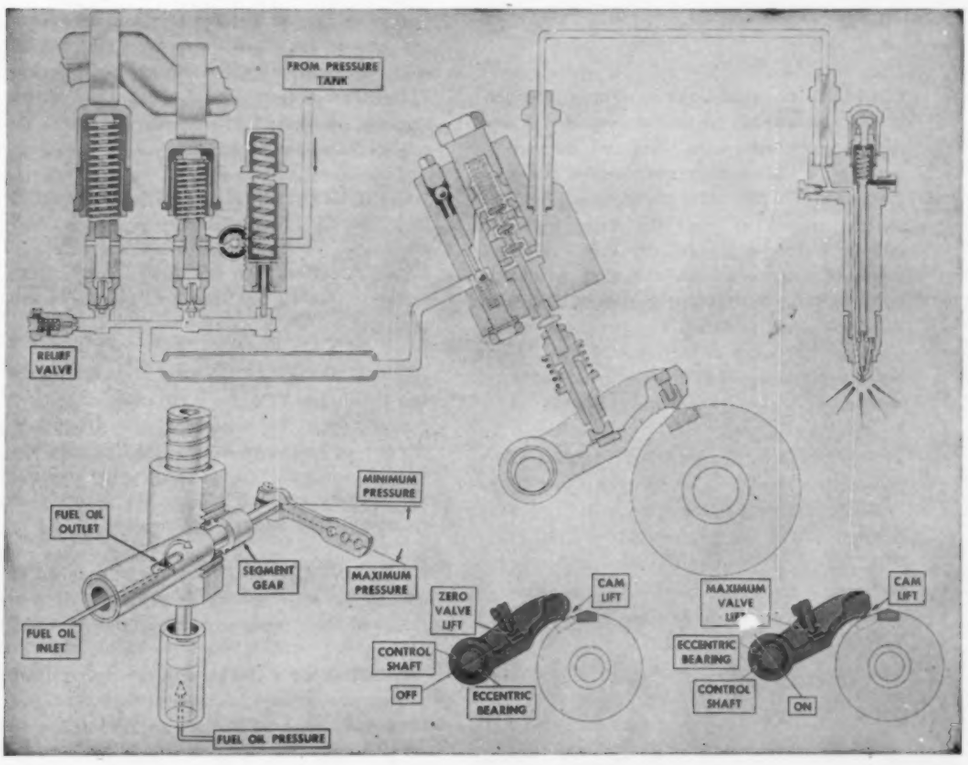
Included in the fuel system is a duplex fuel filter, so arranged that either element can be cleaned while the engine is in operation. Fuel oil transfer pump is a gear type, driven from the fuel pump drive shaft at engine speed, and is directly reversible. One side of the pump supplies fuel to the



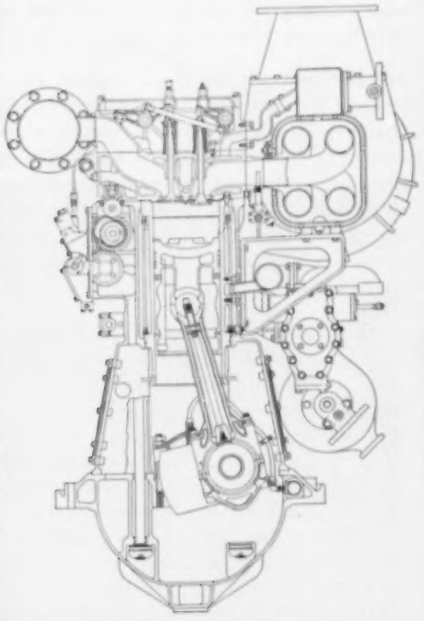
Type GS 6-cylinder direct reversing marine Diesel with sailing clutch.

Dimensional drawing Cooper-Bessemer Type GS direct reversing marine Diesel.

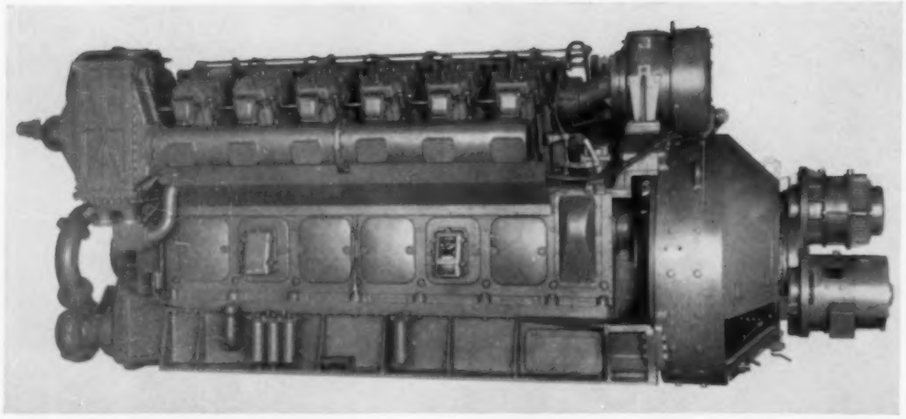




Left. Diagrammatic Arrangement of Cooper-Bessemer Fuel Oil Injection System.

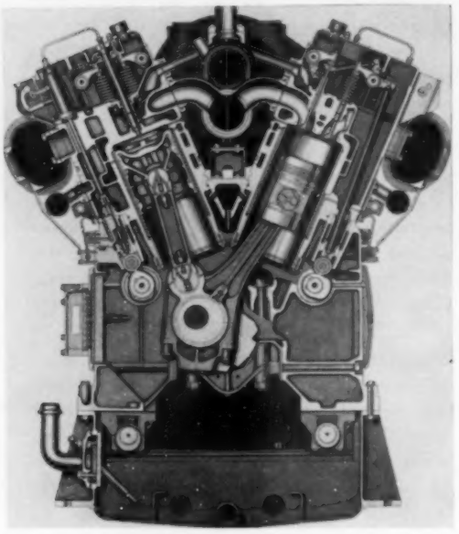


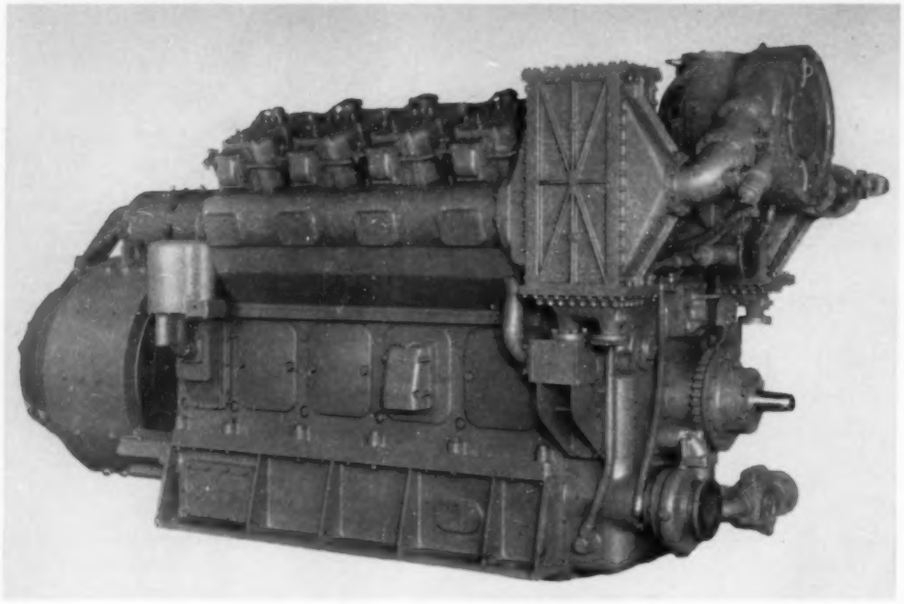
Cross-section of Type GS Supercharged Engine.



Left: Type FVBL 12-cylinder supercharged locomotive diesel.

Below: Cooper-Bessemer FVBL engine cross-sectional view.





Left: Cooper-Bessemer type FVB8 cylinder turbo-charged engine for stationary service.

suction side of the high pressure pump, while the other side picks up fuel from the drip tank and delivers it back to the supply tank.

GOVERNORS for stationary engines are of hydraulic type with hand-controlled synchronizing. Marine engines may have the manual control directly on the fuel controls, or a hydraulic type governor may be used with manual control connected to it. Overspeed governor is of mechanical type for operating on fuel pressure to prevent excessive speed. Governors are gear driven from camshaft drive.

LUBRICATION is by pressure feed to all parts. All engines run dry sump with the exception of the LS, LSV, and stationary models. Oil either drains to the separate sump tank by gravity or is pumped there by a sump pump. The pressure pump takes oil from the sump and delivers it through a cooler to the main oil header inside the crankcase. There are branches from this header to each main bearing, and a supply branch to the camshaft drive and up to the valve gear parts. Many parts have internal drilled passages to help the distribution. Engines are equipped with Cooper-Bessemer ful-flow filters and strainers.

COOLING is by fresh water in all cases. The flow is from the inlet header into the cylinder jackets, the heads, the valve cages when they are used in the larger cylinders the exhaust header jacket, to the discharge header. The JS and LS engines have outside jumpers to carry the water from the cylinder jackets to the cylinder heads. When a supply of water is not available from an outside source, double engine-driven centrifugal circulating water pumps are provided. The fresh water pump circulates the water through the heat exchanger and the engine, and the raw water pump circulates through the heat exchanger and to waste.

STARTING is by compressed air. Starting valves in heads are timed by pilot valves actuated by the camshaft. Marine engines of reversible type have two levers, one for starting and controlling the speed of the engine and one for controlling the power cylinder which moves the camshaft into ahead or astern position by compressed air. Cams have an inclined roller guide between the ahead and astern cam surfaces so designed that exhaust valves are held slightly open during shifting so the cylinders are always vented to aid prompt response in maneuvering.

INLET and EXHAUST HEADERS for the naturally aspirated engines are of cast iron or fabricated steel. Exhaust headers are water jacketed. Turbocharged engines have welded intakes and welded steel exhaust headers of special design for the conditions, with a water-cooled shield surrounding them.

TURBOCHARGERS on the GS, JS and LS models are mounted at the after end for marine and forward for stationary so as to take a minimum of additional space and especially length. These turbochargers are of the exhaust driven type and increase the horsepower output of the engines from 30 to 60 per cent.

VARIOUS COMBUSTION AND CONDITIONING SYSTEMS are available, ranging from simple aftercooling to Cooper-Bessemer's new turbocooling which permits high ratings with low fuel consumption with no deration for high ambient temperatures.

REDUCTION GEARS can be provided for the GS, JS, LS, and LSV engines in cases where lower propeller speeds are required. Engine driven bilge pump is optional, and an attached air compressor, which can be cut in or out of operation at will, is also optional equipment. Thus marine units are completely self-contained power plants.

SELF CONTAINED UNITS can be supplied for oil field or other services by mounting them on skids with their equipment and accessories.

INSTRUMENT PANELS with necessary pressure gauges, tachometer when needed, and pyrometers for exhaust gas temperatures, are mounted at the control station for the operator's convenience.

TYPES FW AND FVBL

The Cooper-Bessemer FW diesels are six cylinder in-line engines 9 in. bore by 10½ in. stroke. The FVB type is built in eight, twelve and sixteen cylinders in V-form. Cylinders are 9 in. bore by 10½ in. stroke.

The FW and the FVB types are locomotive service. They are ruggedly built engines and there are variations in the ratings given them according to the duty of the individual application. Both engines are of similar design.

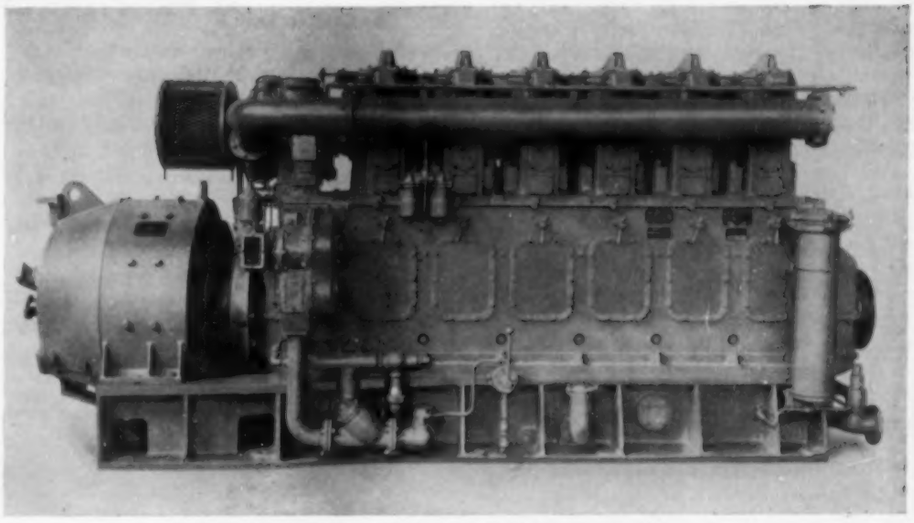
FRAME is a single piece casting of special alloy iron. The lower cross members are machined for the crankshaft main bearings and their caps. The top is planed and bored to take the individual cylinders. Flanges along the lower edges are well below the crankshaft centerline and are arranged to bolt the frame to the base. This base may be a special alloy iron casting or of fabricated and welded steel. It may be just an engine base or it may extend to support the attached generator or other driven machinery. In any case it provides a large sump under the entire engine, baffled to prevent splash. Base and frame combined give a strong and rigid engine structure. Doors are provided on both sides of the frame to give access to the crankcase space and the bearings therein. Camshaft is mounted in the upper part of the frame at one side. V-engines have a cam-shaft on both sides. The two banks of cylinders are at an angle of 45 degrees—22½ degrees on either side of the vertical centerline.

CYLINDER AND CYLINDER HEAD are cast in one piece of alloy iron, with the jacket included, fuel injection nozzle in the center, and a support for rocker arm parts and fuel injection pump. At the side, the cylinder provides an enclosure for the valve push rods. Cylinder wall is precision-honed to a fine working finish. Cooling water flows up around the cylinder walls over the entire top of the cylinder, converging in high velocity flow around the injection nozzle. Arrangements are provided to quickly and easily lift and replace any cylinder for its inspection or of the piston. Piston can then be removed if desired without disturbing the crankpin bearings.

CRANKSHAFT is made from a single steel forging or from an alloy iron casting. It is of large diameter, exceeding 80 per cent of the cylinder bore. It is machined to close tolerances and carefully balanced. Journals and pins are drilled to carry lubricating oil from the main bearings through to the crankpin bearings.

MAIN BEARING shells are of precision type, and are held firmly in place by the forged steel bearing caps. These caps are closely fitted between side facings in the frame and a through bolt cross ties the frame and cap. Main bearing bolts are also through bolts.

CONNECTING RODS are die forged ribbed for strength and ridigity. V-engine rods are of articulated design with one rod serving as the master. All rods are rifle drilled for lubricating oil. Crankpin bearings are precision-type shells, and are held by forged steel bearing caps bolted to the rods by four high-tensile steel studs. Upper end of rods have the usual Cooper-Bessemer patented piston pin.



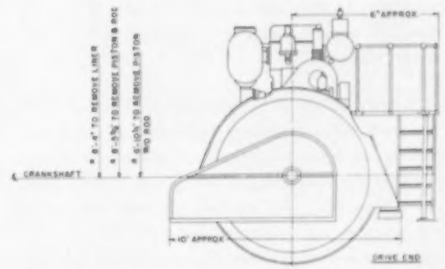
Cooper-Bessemer FW locomotive engine-generator unit.

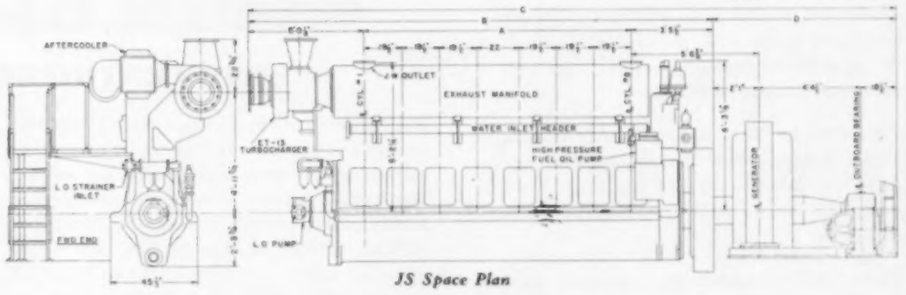
PISTONS are of alloy cast iron with the crown and the ring belt oil cooled.

VALVES, INLET AND EXHAUST; there are two of each in the cylinder head. Exhaust valves are heat and corrosion resistant. Valve seats and guides are replaceable. Valve rockers are actuated by push rods from the camshaft, with cross push rods for the far side valves.

DIMENSIONS	NO OF CYLINDERS	
	8	12
A	8'-4"	9'-11½"
B	16'-9½"	19'-5½"
C	24'-9½"	28'-5½"
±D	0'-0"	0'-0"

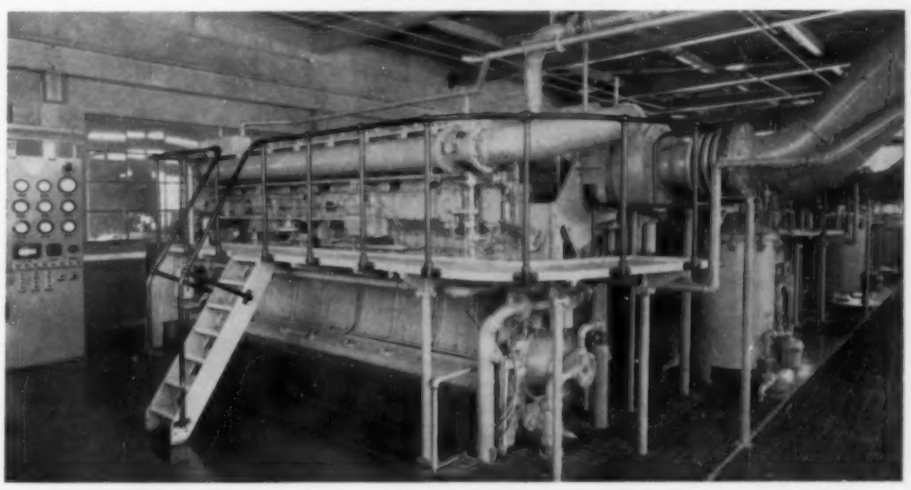
*AVERAGE GENERATOR AND EXCITER





JS Space Plan

Type JS 6-cylinder Gas-Diesel.



are shaped to give smooth gas flow. Valves and valve gear on top of cylinder are fully enclosed by a cover easily removed for inspection purposes.

CAMSHAFT is gear driven from the crankshaft. The same gear train drives the accessories. Camshaft is steel with cams keyed to shaft.

FUEL INJECTION PUMPS are mounted in the cylinder heads and are actuated by push rods from the camshaft. Connections to the fuel injectors are very short. Pumps and injectors are quickly exposed for inspection by removing the enclosure covers. Injection pumps are controlled by a shaft running the length of the engine and connected to the governor. Governor is of a type suitable for individual installation requirements and is gear driven from the camshaft drive train.

INTAKE MANIFOLD is of welded steel, bolted to the cylinder assemblies at one side on the in-line engines and on the outside of the banks of cylinders on the V-engines. EXHAUST MANIFOLD is also of welded steel construction; water jacketed for the naturally aspirated engine, and water blanketed to reduce radiation for the turbocharged engines. Manifold is supported from the frame at the side or in the V of the engine by brackets. Twelve and sixteen cylinder V-engines have two turbochargers, one mounted at each end of the engine.

LUBRICATION is by pressure feed to all bearings and parts including the valve gear. Piston cooling oil is included in this system and is supplied to the space under the piston crowns from the piston pins. All cooling oil and lubricating oil drains to the crankcase and base. Engines are furnished wet or dry sump to suit installation conditions. Oil pumps are mounted at the side of the frame and driven from the camshaft gear train. Oil is delivered through an oil cooler and a strainer to the engine header.

COOLING SYSTEM includes double centrifugal pumps—V-engines have two pumps—with one impeller for jacket water and one for raw water. Pumps are driven from crankshaft by accessory gear drive.

STARTING is normally by compressed air with the air valves in the cylinder heads timed by the pilot valves actuated from the camshaft.

GAS DIESELS

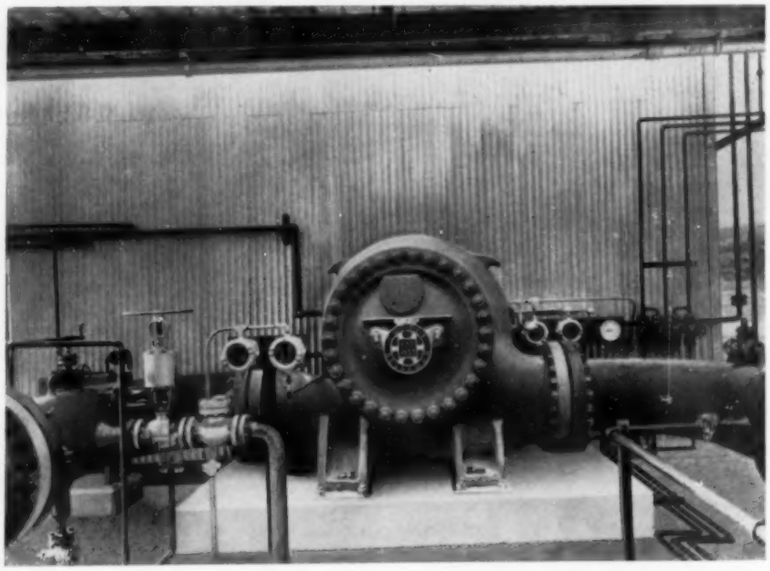
Cooper-Bessemer has developed a simple means of burning gas fuel, or a combination of oil and gas fuel, in most of their stationary naturally aspirated or turbocharged engines now in production or in service in the field. They are instantaneously convertible under any load from oil to gas fuel, or vice versa, or to varying combinations of both fuels. If desired, controls can be provided which permit the engine to burn all gas available and automatically make up the remainder from the fuel oil supply. Fuel economy for gas Diesels equals or exceeds that for straight oil engines. A turbocharged engine under test has shown a low figure of 6350 Btu. per bhphr., representing a brake thermal efficiency of over 40 per cent.

SUPERCHARGED GAS ENGINE

Developments resulting from the first commercial installation in 1949 by Cooper-Bessemer have made it possible to supercharge the four cycle spark-ignited gas engine. These engines offer a 50 per cent higher thermal efficiency than ordinary gas or gasoline engines, consuming less than 6600 btu. per horsepower hour which means a fuel saving of 33 per cent over the conventional gas engines. By successfully increasing the brake-mean-effective pressure from the usual 70 pounds to 165 pounds, this engine produces 133 per cent more hp. in the same space and weight as required for the ordinary gas engine.

The supercharged gas engine has practically no increase in space or weight and the foundation and building requirements are the same as that of an ordinary gas engine. Due to the fact that heat dissipation is not increased, cooling equipment which served the atmospheric gas engine will also serve the supercharged engine despite its increased horsepower. Maintenance has been shown to be less per hp. than the atmospheric engine. All diesel engines, with the exception of the type FW and FVB, are built as supercharged gas engines.

Gulf Interstate Gas Company's installation at Stanton, Kentucky. Here a Cooper-Bessemer type RFB-24 centrifugal compressor handles 400 million cu. ft. of gas per day at 935 PSI. It is driven by an LSV12 supercharged gas engine equipped with an AT type turbo cooler.



RFB CENTRIFUGAL COMPRESSORS

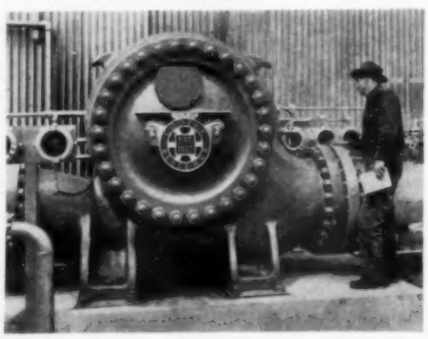
The Cooper-Bessemer RFB line of centrifugal compressors has been designed especially to meet the requirements of the natural gas pipe line industry. The RFB line consists of three sizes of single stage centrifugal compressors—the RFB-20, RFB-24 and RFB-30. Each size indicates the flange size for that particular unit as, for example, the RFB-24 which has 24" ASA flanges on both suction and discharge nozzles. These compressors offer simplicity of construction with a flexibility of design for meeting the wide range of operating conditions typical of gas transmission line design.

RFB compressor casings are constructed from heavy-walled steel castings. Both suction and discharge flanges are on a common horizontal center line normal to the center line of the shaft. Access to all moving parts is obtained through a large cover plate on the front of the machine. Maximum flexibility for meeting wide ranges of operating conditions has been achieved through the use of interchangeable parts in the inlet and discharge gas passages and by a wide range of permissible impeller sizes and operating speeds.

Impellers for RFB compressors are fabricated from weldments of alloy steel forgings. With this construction it is possible to completely finish all internal passages of the impeller, thus contributing to the high efficiency which these impellers have achieved. Top speeds in excess of 1,000 ft per second are permissible with this design. It is now possible to design high head single stage compressors for two unit parallel operation or for large single unit stations.

The RFB centrifugal compressor is designed with

Gulf Interstate Gas Company's installation at Stanton, Kentucky. Here a Cooper-Bessemer type RFB-24 centrifugal compressor handles 400 million cu. ft. of gas per day at 935 PSI. It is driven by an LSV12 supercharged gas engine equipped with an AT type turbo cooler.



the rotating assembly including shaft, seals, and bearings contained in one assembly. If necessary, this assembly can be removed from the machine and replaced with a spare assembly. The shaft is supported in two precision type main bearings. In order to obtain the maximum bearing span, the impeller end main bearing has been incorporated in the shaft seal. Shaft overhang is thus minimized contributing further to the smooth operation of these compressors.

A double Kingsbury thrust bearing handles the the end thrust imposed upon the shaft by the high operating pressures at start-up and by the normal impeller thrust during operation.

Shaft seals on the RFB compressor are of the oil film type and consist of two stationary close-fitting, babbitt-lined steel sleeves which align themselves in a radial direction to the compressor shaft. Oil is fed into the seal chamber between the sleeves at a pressure maintained slightly above the gas pressure in the compressor casing from a high pressure pump or, in the event of a failure of the pump, from an overhead emergency tank usually mounted on the compressor casing or in the compressor building structure. The high pressure seal oil pump, overhead seal oil tank, all compressor mounted oil piping, and the necessary seal oil control equipment are usually furnished as an integral part of the compressor unit.

COOPER-BESSEMER DIESELS

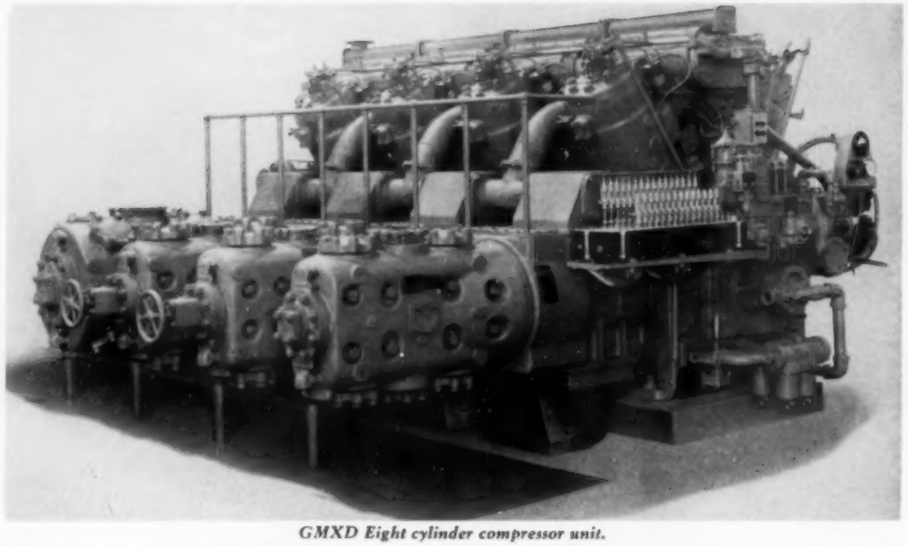
Model	Use	Cycle	No. Cyls.	Bore & Stroke	H.P.	R.P.M.	Fuel System	Starting	Super-Charge	Rev. Gear	Length	Width Between Bolt Centers	Height Above Shaft	Weight
FW6	S	4	6	9 x 10½	430	1000	BS	A	—		130	34¾	80	17,800
FW6T	S	4	6	9 x 10½	910	1000	BS	A	TC		176	34¾	80	18,300
FVB8	S	4	8	9 x 10½	575	1000	BS	A	—		102	43⅛	57⅜	22,000
FVBL12	S	4	12	9 x 10½	860	1000	BS	A	—		140	43⅛	57⅜	26,000
FVBL16	S	4	16	9 x 10½	1150	1000	BS	A	—		165	43⅛	57⅜	32,000
FVBL8T	S	4	8	9 x 10½	1210	1000	BS	A	TC		124	43⅛	57⅜	22,000
FVBL12T	S	4	12	9 x 10½	1815	1000	BS	A	TC		140	43⅛	57⅜	32,000
FVBL16T	S	4	16	9 x 10½	2420	1000	BS	A	TC		165	43⅛	57⅜	50,000
GS6	S	4	6	10½ x 13½	565	750	O	A	—		142½	37½	67¼	21,500
GS8	S	4	8	10½ x 13½	755	750	O	A	—		175	37½	67¼	29,500
GS6T	S	4	6	10½ x 13½	1190	750	O	A	TC		174	37½	67¼	22,250
GS8T	S	4	8	10½ x 13½	1590	750	O	A	TC		206½	37½	67¼	30,250
GSVA12	S	4	12	10½ x 13½	1130	750	BS	A	—		212	56½	96¾	59,000
GSVA16	S	4	16	10½ x 13½	1510	750	BS	A	—		254¼	56½	95¾	70,000
GSVA12T	S	4	12	10½ x 13½	2380	750	BS	A	TC		212	56½	96¾	61,000
GSVA16T	S	4	16	10½ x 13½	3180	750	BS	A	TC		254¼	56½	96¾	75,000
JS5	S	4	5	13 x 16	515	450	O	A	—		149	44¼	79⅛	41,000
JS6	S	4	6	13 x 16	705	514	O	A	—		171	44¼	79⅛	44,000
JS7	S	4	7	13 x 16	820	514	O	A	—		193	44¼	79⅛	48,000
JS8	S	4	8	13 x 16	935	514	O	A	—		210	44¼	79⅛	51,000
JS6T	S	4	6	13 x 16	1485	514	O	A	TC		199½	44¼	79⅛	45,000
JS7T	S	4	7	13 x 16	1735	514	O	A	TC		218	44¼	79⅛	49,500
JS8T	S	4	8	13 x 16	1980	514	O	A	TC		238½	44¼	79⅛	52,000
LS6	S	4	6	15½ x 22	965	360	O	A	—		224	55⅛	120	76,000
LS7	S	4	7	15½ x 22	1125	360	O	A	—		248	55⅛	120	91,000
LS8	S	4	8	15½ x 22	1285	360	O	A	—		276	55⅛	120	106,000
LS6T	S	4	6	15½ x 22	2040	360	O	A	TC		251	55⅛	120	77,000
LS7T	S	4	7	15½ x 22	2380	360	O	A	TC		275	55⅛	120	84,700
LS8T	S	4	8	15½ x 22	2720	360	O	A	TC		299	55⅛	120	107,000
LSV12	S	4	12	15½ x 22	1925	360	O	A	—		252	68	117	194,500
LSV16	S	4	16	15½ x 22	2565	360	O	A	—		307	68	117	232,500
LSV12T	S	4	12	15½ x 22	4100	360	O	A	—		300	68	117	197,500
LSV16T	S	4	16	15½ x 22	5450	360	O	A	TC		355	68	117	237,500
GS6DR	M	4	6	10½ x 13½	565	750	O	A	—	DR	175	37½	67¼	34,000
GS8DR	M	4	8	10½ x 13½	755	750	O	A	—	DR	208	37½	67¼	42,000
GS6DRT	M	4	6	10½ x 13½	1190	750	O	A	TC	DR	178	37½	67¼	36,000
GS8DRT	M	4	8	10½ x 13½	1590	750	O	A	TC	DR	210	37½	67¼	44,000
GSVA12DR	M	4	12	10½ x 13½	1130	750	S	A	—	DR	212	56½	96⅝	61,000
GSVA16DRT	M	4	16	10½ x 13½	1510	750	S	A	—	DR	254¼	56½	96⅝	72,000
GSV12DRT	M	4	16	10½ x 13½	2380	750	S	A	TC	DR	212	56½	96⅝	63,000
GSV16DRT	M	4	12	10½ x 13½	3180	750	S	A	TC	DR	254¼	56½	96⅝	75,000
JS6DR	M	4	6	13 x 16	705	514	O	A	—	DR	177	44¼	79⅛	46,000
JS8DR	M	4	8	13 x 16	935	514	O	A	—	DR	216	44¼	79⅛	55,000
JS6DRT	M	4	6	13 x 16	1485	514	O	A	TC	DR	177	44¼	79⅛	50,000
JS8DRT	M	4	8	13 x 16	1980	514	O	A	TC	DR	216	44¼	79⅛	60,000
LS6DR	M	4	6	15½ x 22	965	360	O	A	—	DR	239	55⅛	120	90,000
LS8DR	M	4	8	15½ x 22	1285	360	O	A	—	DR	287	55⅛	120	110,000
LS6DRT	M	4	6	15½ x 22	2040	360	O	A	TC	DR	239	55⅛	120	91,000
LS8DRT	M	4	8	15½ x 22	2720	360	O	A	TC	DR	287	55⅛	120	111,000
LSV12DR	M	4	12	15½ x 22	1925	360	O	A	—	DR	243	68	117	197,000
LSV16DR	M	4	16	15½ x 22	2565	360	O	A	—	DR	298	68	117	235,000
LSV12DRT	M	4	12	15½ x 22	4100	360	O	A	TC	DR	263	68	117	200,000
LSV16DRT	M	4	16	15½ x 22	5450	360	O	A	TC	DR	341	68	117	240,000

Engines have open combustion chamber. Models marked M for Marine use only. All Stationary models except FVBL and FW are available as gas or Gas-Diesels. (Atmospheric or Supercharged.)

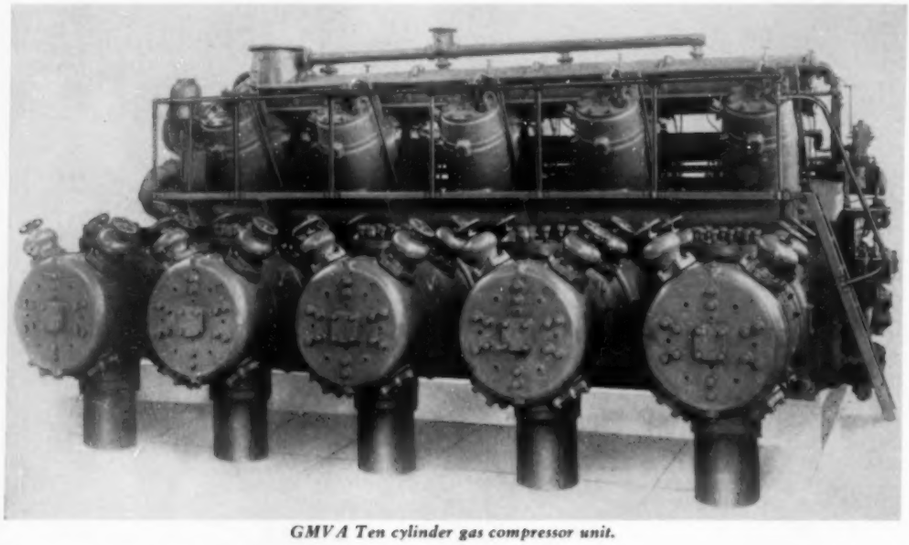
COOPER-BESSEMER TWO CYCLE GAS COMPRESSOR UNITS

The Cooper-Bessemer line of gas engine driven compressor units are designed to handle a wide range of gas compression applications. Great flexibility is achieved with the many horsepower and compressor cylinder combinations available. The engines are of the two-cycle, V-type driving integral compressor cylinders; the result being a compact unit suitable for use in the gas transmission, gasoline extraction, refrigeration and petro-chemical industries. V-type construction allows greater horsepower for a given floor space.

Cooper-Bessemer two-cycle gas engines are built in three frame sizes, the GMX, the GMV and the GMW. The GMV and GMW engines are available as centrifugally scavenged and series turbocharged units. Each frame size is available in various numbers of power cylinders per unit, providing increments of increased horsepower within the rating of the type of engine. This type of construction means greater interchangeability of parts thus requiring less stockage of spare parts. Low rotative speeds mean reduced wear of moving parts.



GMXD Eight cylinder compressor unit.

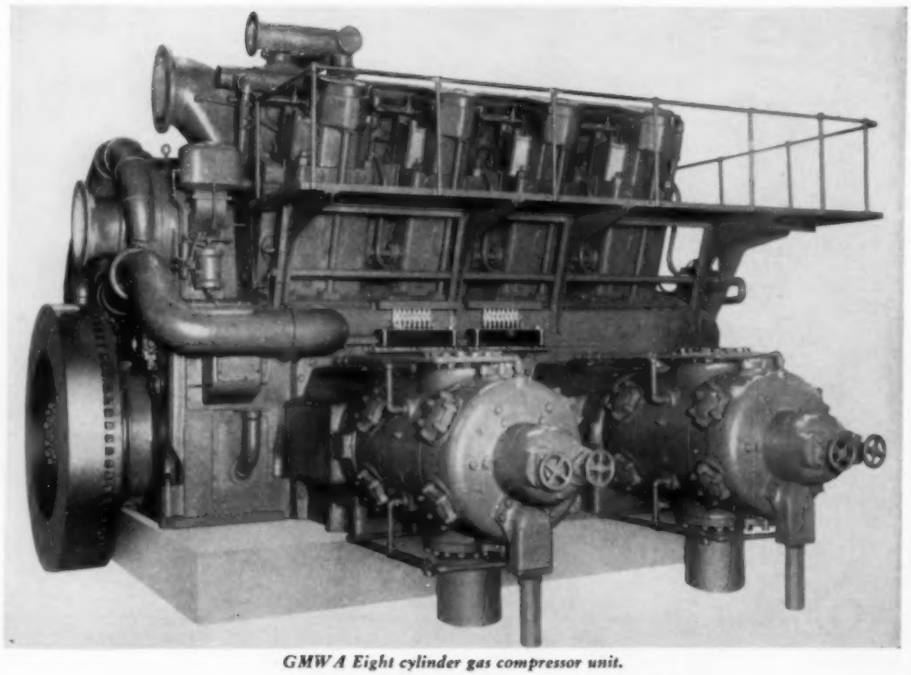


GMVA Ten cylinder gas compressor unit.

The crankshaft is of forged steel precision machined. The large diameter stiff crankshaft is provided with a flywheel adequately designed for speed control and added flexibility. Crankshaft counterweights are properly sized for minimum vibration and smooth performance. The counterweights are available to meet the most exacting or unusual balancing requirements. These counterweights, by counteracting the inertia forces of the moving masses at their points of origin, achieve balance of forces and force couples without large internal strains in either the frame or the crankshaft. Foundation requirements are thus at a minimum. The GMXD is especially well adapted to mounting on barges or pilings.

All main bearings are of the precision type which are interchangeable and replaceable without scraping or fitting.

The base or frame of each engine has openings or jaw type construction to permit removal and installation of the crankshaft from the side. This is a very desirable feature since servicing of the crankshaft may be accomplished without the usual necessary removal of the upper half of the engine. The rigid base is cast in one piece of high strength Meehanite metal. Ready access to bearings and enclosed working parts is possible by removing large side cover plates. This construction, combined with the use of vertically split bearing shells, permits easy checking and adjustment or replacement of main bearings. The base is precision bored in a single set-up to assure perfect alignment of the main bearings.



GMWA Eight cylinder gas compressor unit.

There is one main bearing for each crankthrow, or pair of power cylinders, plus two at the flywheel end, allowing use of a heavier flywheel for smooth operation, without requiring an outboard bearing. Crankpin bearings are also of the precision type. The bearing loads on these are low, and evenly distributed on the crankpin by the use of articulated connecting rods which permit the use of a single large crankpin bearing.

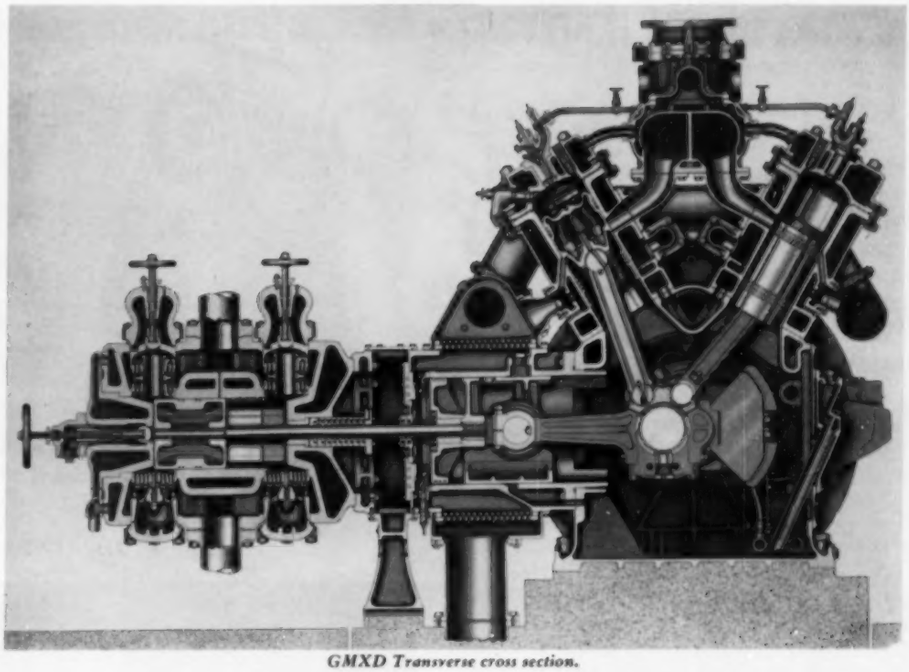
The unique design of the articulated connecting rod affords exceptional bearing area with even distribution of bearing load. The horizontal compressor rod serves as the master, with the two power connecting rods linked to it by individual pins. The power connecting rods have the patented "saddle end" pin construction, with full length bronze bearings, providing twice the bearing area otherwise possible.

Power cylinders are cast of Meehanite metal, combining strength and unusual wear resistance. The cylinders are cast with a water jacket which is designed to provide a rapid flow of cooling water around the top of the cylinder where heat transfer is most important. Cooling water is transferred to the head through water jumpers, eliminating the need for a seal between cylinder and head and making water leakage into the cylinder impossible. The power cylinders are designed with intake and exhaust ports cast in the cylinder walls, thus the only valve required in the cylinder head is the gas injection valve. A balancing valve is provided in the fuel line to each power cylinder and is adjusted to obtain load balance or equal load distribution among the power cylinders. Pistons are tin-plated and of trunk type with symmetrical construction. Each is cast of high-grade Meehanite metal. The piston crown is supported by multiple ribs extending to a separate piston pin carrier, permitting the use of thin and uniform piston walls. It also permits the use of a symmetrical piston design eliminating distortion from thermal expansion.

Each piston carries four narrow type compression rings and two oil control rings. Extensive wear research and years of field operation have proved conclusively that the use of narrow rings results in longer life for both rings and cylinders. Narrow rings also permit the use of shorter pistons without shortening the piston skirt. This reduces the reciprocating weight, lowers bearing loads, and lessens vibration.

Power pistons are designed to include a cooling chamber in which lubricating oil enters under pressure. The cooling-oil outlet is so located that the chamber never fills completely with oil. This oil is agitated violently by the up and down motion of the piston and gives the same result as ice and liquid shaken in a container . . . . it cools evenly and efficiently. This is known as Cooper-Bessemer's "Cocktail Shaker" principle.

The fuel injection system used on all Cooper-Bessemer V-angle engines has been trade-named the "Silent Scot" because it provides silent operation and exceptional fuel economy. As it is designed to operate with minimum clearances, the injector valve gear makes for a quiet running engine and reduced valve gear wear. The extraordinary fuel economy achieved by the "Silent Scot" injection system is due largely to the fact that fuel is admitted to the cylinder almost simultaneously with the close of the scavenging event, thus preventing loss of fuel in the scavenging air stream. In addition to fuel economy the system results in better combustion and regular firing at reduced loads.

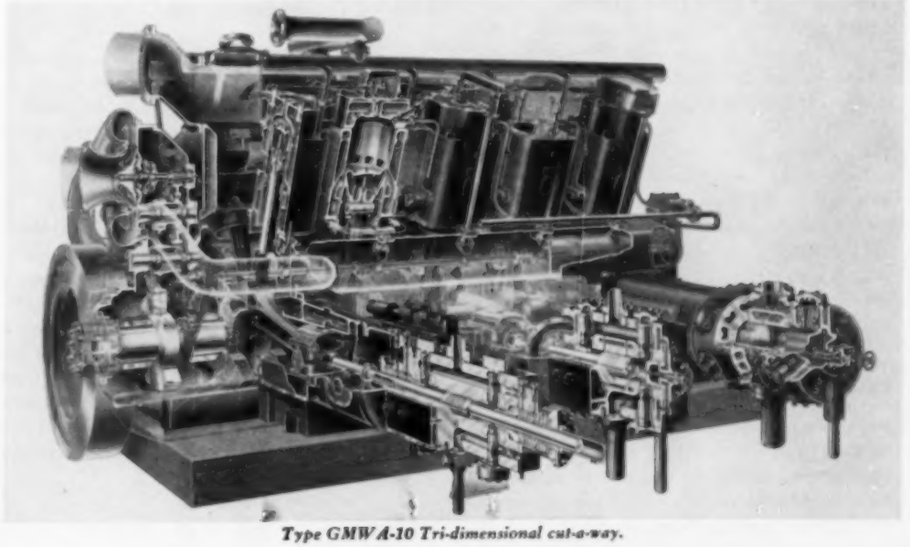


GMXD Transverse cross section.

Full pressure lubrication is supplied to all main, crankpin, piston pin, crosshead and auxiliary driveshaft bearings by a built-in rotary type lube oil pump mounted on the end cover of the engine base. Lubricating oil is delivered through a full flow filter, then through the cooler and a strainer to the distribution header which is located in the base.

The engine is equipped with full flow filtration to provide the ultimate in protection against foreign particles being carried in the circulating lubricating oil. The full flow filter is a steel shell containing filter elements operating in parallel. These elements are replaceable. Pressure regulating valves maintain the desired oil pressure and assure that proper quantities are being delivered to all points in the system. Force feed lubricator pumps supply lubricating oil to power and compressor cylinder walls as well as to compressor rod packings.

Control panels have been developed to sequence automatically the starting of the engines and to place the unit on the line. These controls are available for fully automatic operation, including starting and speed control; semi-automatic, automatic start, with speed control; or any desired variation. The controls have been developed for electric, electric pneumatic and pneumatic operation. Usually the electric pneumatic combination works best for control operation.



Type GMWA-10 Tri-dimensional cut-a-way.

The control circuit contains safety features for both start-up and running time. Safety shut-downs can be provided with indicators to show the cause of a shutdown. Standard shutdown controls are high jacket water temperature, low lube oil pressure, and engine overspeed. Additional shut-downs such as discharge gas pressure and temperature are available. (Alarm circuits allow visual and audible indications of approaching trouble. In addition to alarms for the shutdown devices, alarms are also commonly used for high jacket water temperature, high lube oil temperature, low air presure, and discharge gas temperature or pressure, or both.)

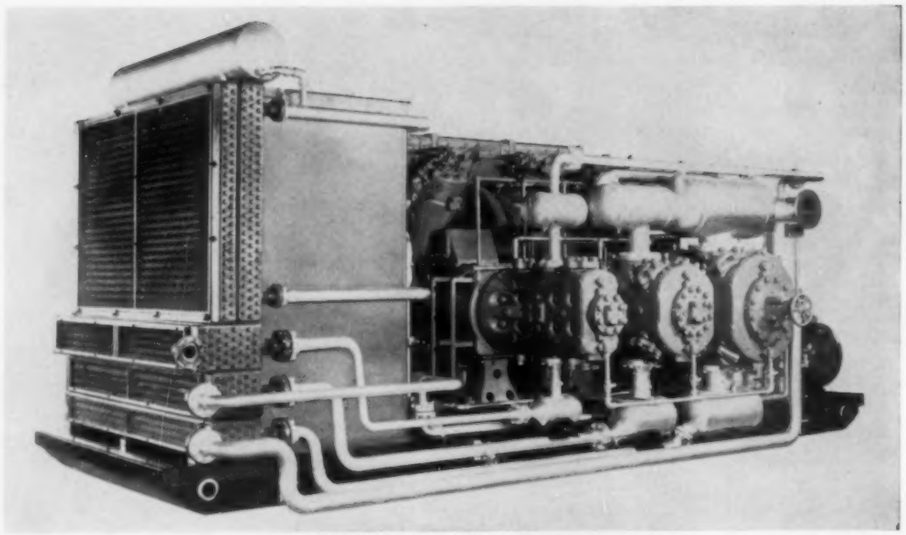
2-CYCLE GAS COMPRESSOR UNIT RATINGS

	Bore & Stroke	BHP
GMXD-4	9¾″ x 10½″	265
GMXD-6	9¾″ x 10½″	400
GMXD-8	9¾″ x 10½″	550
GMXD-10	9¾″ x 10½″	660
GMVA-4	14″ x 14″	540
GMVA-6	14″ x 14″	800
GMVA-8	14″ x 14″	1100
GMVA-10	14″ x 14″	1350
GMWA-6	18″ x 20″	1500
GMWA-8	18″ x 20″	2000
GMWA-10	18″ x 20″	2500

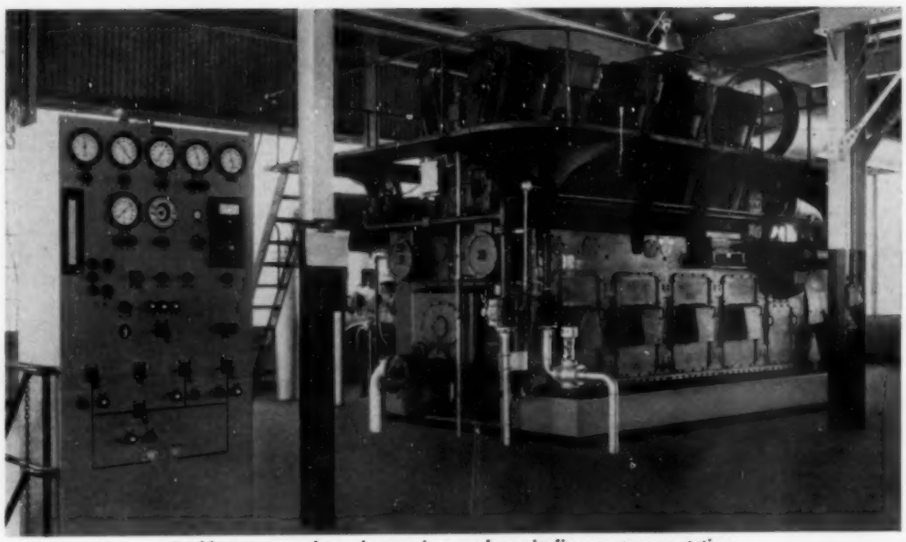
Cooper-Bessemer offers a safety shut-down which cuts off the fuel to the engine rather than cutting off the ignition. By this method, there is no possibility of the engine continuing to operate should pre-ignition provide the "spark" for the fuel charge. The amount of raw gas remaining in the gas inlet passages is kept to a minimum, thereby preventing explosion when shutting the engine down or when re-starting.

These shut-off controls are positive acting and require manual resetting. This eliminates any possibility of trouble resulting from ignition being cut and a moment later being established. The Cooper-Bessemer safety system has been designed to offer maximum safety to both the operator and the equipment.

The compactness of the GMXD makes it well suited for services in which a packaged unit is preferred. The package consists of the complete compressor unit prefabricated to include all auxiliary equipment including the jacket water cooling, lube oil cooling, gas cooling and complete starting and operating accessories. All necessary pumps are built-in, direct driven from the engine. This equipment is completely shop assembled and mounted on a structural steel base and shipped as a packaged unit. The inherent compactness combined with the simplicity of the two-cycle design makes this unit a "natural" for remote field operating stations with only occasional attendance.



Type GMXD Six cylinder packaged unit.



Pushbutton control panel set-up in a modern pipeline compressor station.

Compressors

Versatility of the engine line is greatly increased by the availability of a wide range of compressor cylinders. By varying the number and diameter of compressive cylinders, any combination of capacity and pressure is available within the limits of the engine's horsepower rating. As no crank throws are devoted exclusively to compressing scavenging air, each pair of power cylinders can be utilized for driving a compressor cylinder.

Cooper-Bessemer compressor cylinders are designed for low vacuums or the highest pressures, and are available to meet any requirement—industrial or process air, gas transmission, gasoline extraction, refrigeration and various needs in refineries and chemical plants.

Advanced metallurgy combined with correct design affords more than ordinary strength and rigidity. Low and medium pressure compressor parts are of Meehanite Metal. For services which require strength and toughness beyond that of Meehanite Metal, Cooper-Bessemer offers ductile iron. This material has superior mechanical properties and provides strength comparable with that of steel. For the higher pressure ranges a complete line of cast steel and forged steel compressor cylinders are available.

Compressor cylinder valves are usually of the standard concentric ring plate type and are self-cleaning. Poppet or channel valves may be furnished at the customer's request. Valve seats are renewable and are usually made of Meehanite Metal except for high pressure operation, where high strength alloy seats are used. Suction and discharge valves are interchangeable, resulting in a lower requirement for spare parts inventory.

Double deck valves are available in place of the single deck valve types. The double deck design, developed by Cooper-Bessemer, reduces valve velocity and provides equivalent self-unloading due to high clearance volumes. For additional flexibility, valve cap clearance pockets can be added where the added clearance of the double deck valve alone is not enough to effect the desired unloading of the unit. Clearance pockets are available in any size necessary to give required clearance volume. The use of valve cap clearance pockets of different sizes and volumes maintains constant full load ratings on the engine at all times. This means more capacity throughout for the machine at a lower specific fuel consumption.

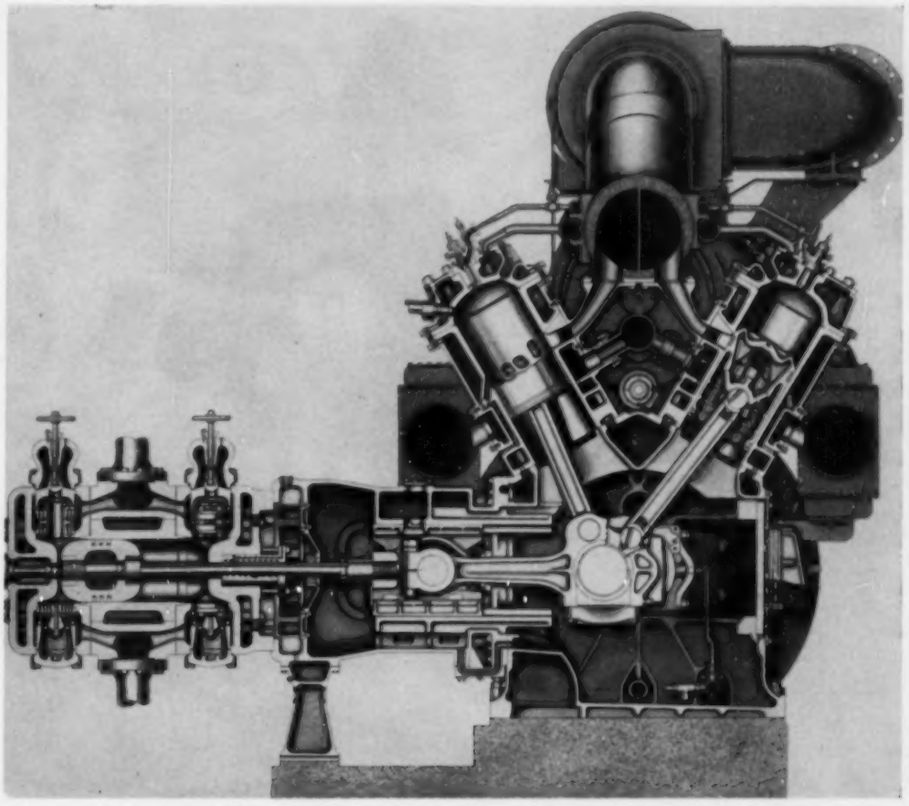
V-ANGLES WITH SERIES TURBOCHARGING

SERIES TURBOCHARGING SYSTEM—Air for scavenging and combustion is first compressed by either a single exhaust-driven turbocharger or a pair of such turbochargers operating in parallel, depending on engine size. Following this initial compression, the air is discharged into an engine-driven blower for second stage compression. Delivery is then made to separate aftercoolers, to remove some of the heat of compression and thus into the air headers serving each bank of power cylinders. This remarkable advancement in turbocharging contributes to greatly increased engine output and improved performance in three basic ways. First it converts an unusually high amount of waste heat to usable power as attested by greatly increased thermal efficiency with reduced fuel consumption. Second, it results in more effective scavenging than ever before. Third, it assures the abundant clean air for the combustion cycle that permits and makes the most of high compression operation.

IMPROVED AIR UTILIZATION—The efficient *use* of air is of course just as important as an abundant supply. This involves both the *flow* of air and the *conditioning* of air. In the series turbocharged V-angles the power cylinder air ports are not only constructed as venturi passages to minimize pressure drop, but each passage provides for controlled air flow direction. Thus exhaust gases are actually swept out of the cylinders ahead of the scavnging air, instead of allowing haphazard mixing. And since the fresh air remaining is abundant and undiluted, higher combustion efficiency and greater power than otherwise possible are the result. Cooler, denser air, the result of Cooper-Bessemer twin aftercooling, also contributes greatly to this increased power and efficiency.

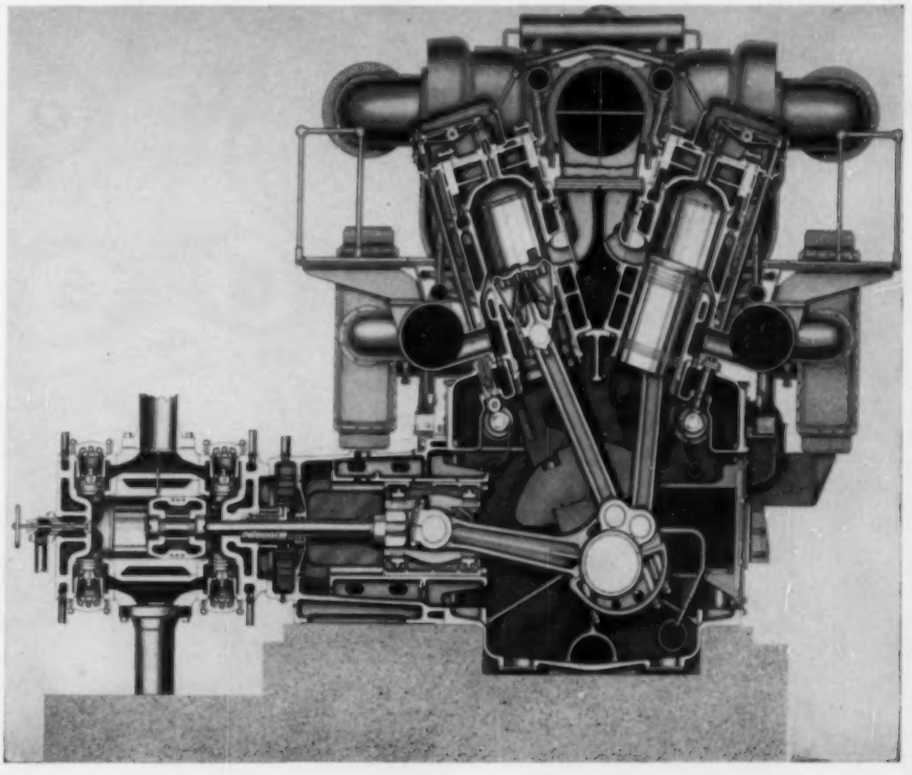
FULL RANGE EFFICIENCY—It is particularly important to note that the effective performance of Cooper-Bessemer series turbocharging is by no means limited to full load or full speed operation. The more or less severe short-comings of other turbocharging systems in this respect is one of the basic reasons for Cooper-Bessemer's development of series turbocharging. Due to the series arrangement, with an engine-driven blower for second stage compression, the engine at its start or at any partial load is not completely dependent on exhaust pressure or exhaust heat for supercharging effect. The engine is supercharged from the moment it starts and throughout all speeds and loads. Moreover, high efficiency is maintained even at fractional loads.

GMWC . . . Bore: 18 inch—Stroke: 20 inch
6 power cylinders . . . . . 2000 bhp
8 power cylinders . . . . . 2800 bhp
10 power cylinders . . . . . 3500 bhp
GMVC . . . Bore: 14 inch—Stroke: 14 inch
4 power cylinders . . . . . 720 bhp
6 power cylinders . . . . . 1100 bhp
8 power cylinders . . . . . 1440 bhp
10 power cylinders . . . . . 1800 bhp
GMXC . . . Bore: 9¾ inch—Stroke: 10½ inch
This unit, in 4, 6, 8 and 10 cylinder sizes, covers a lower horsepower range and will be available by late 1957.



Cross-section view of series turbocharged type GMVC 10-cylinder engine.

Cross-section of Cooper-Bessemer series turbocharged 10-cylinder GMWC V-angle compressor rated 3500 bhp at 250 rpm.



PERKINS

DIESEL engines manufactured by F. Perkins Ltd., of Peterborough, England, are providing power on land and water in nearly every country, including the United States and Canada. The Perkins plant is producing 300 diesel engines a day. At least 70 per cent of production is exported, either directly or indirectly, to 143 countries. Perkins engines are produced for more than 420 different applications, varying from power units for vehicles, tractors and farm machinery to industrial equipment, shunting locomotives and boats of various types.

There is a wide range of Perkins engines. The well tried 'P' Series, comprising three, four and six cylinder engines, are almost identical except for the number of cylinders, allowing standardization. All the 'P' series—the P3, P4, and P6,—are popular in the automotive field and have many other applications. They have a high camshaft, and the cylinder head is a single chromium iron casting carrying tappets and rocker gear with two overhead valves per cylinder. The fuel pump is of the unit type, and is fitted with a pneumatic governor, which enables the engine speed to be controlled entirely by the throttle. The camshaft and fuel pump shaft are driven by triple roller chain with automatic tensioner.

High pressure forced lubrication is used throughout the 'P' series engines. The oil pump is driven through spiral gear from the fuel pump drive shaft. The cylinder block is a single casting of nickel chrome cast iron alloy and dry liners are fitted. The crankshaft is a forging of nickel chrome molybdenum steel, heat treated and hardened on

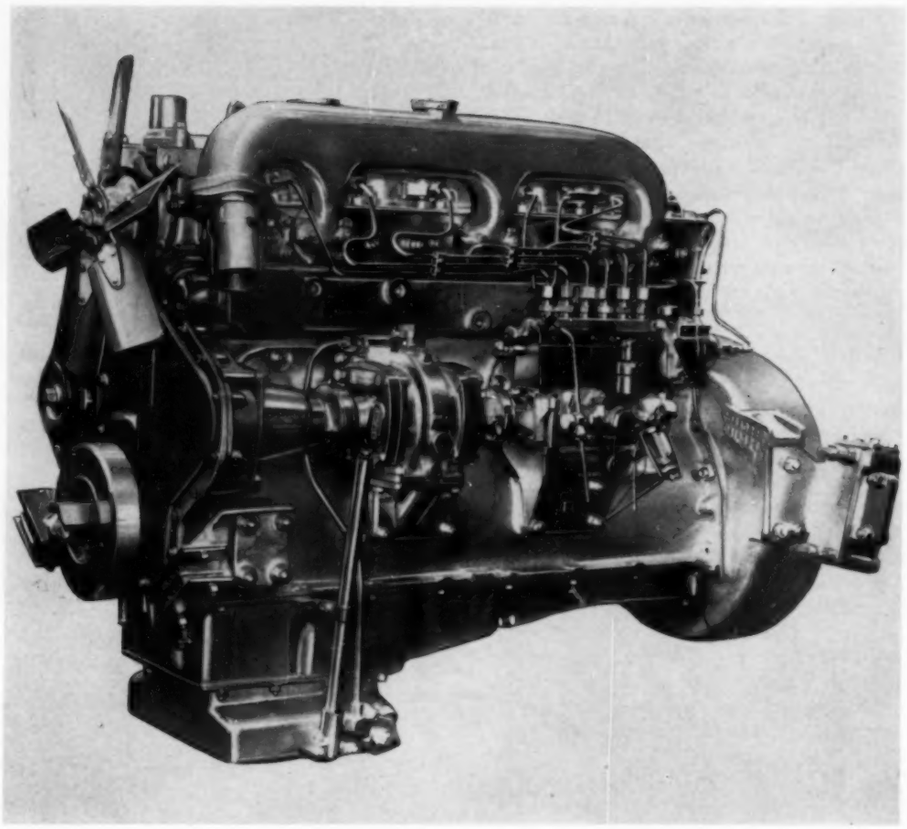


Figure 1

Figure 2

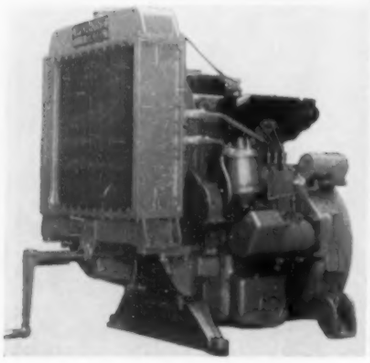


Figure 3

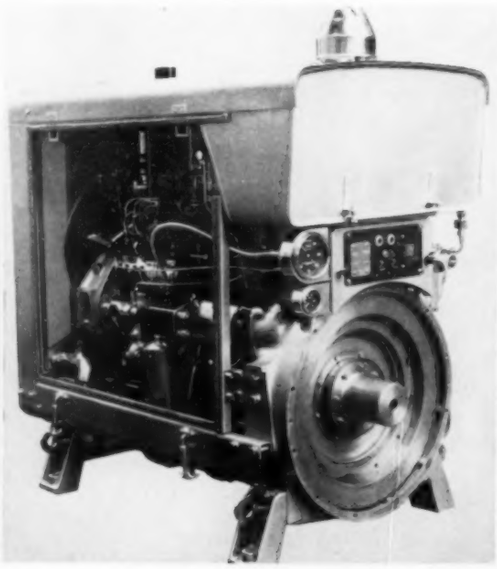


Figure 4

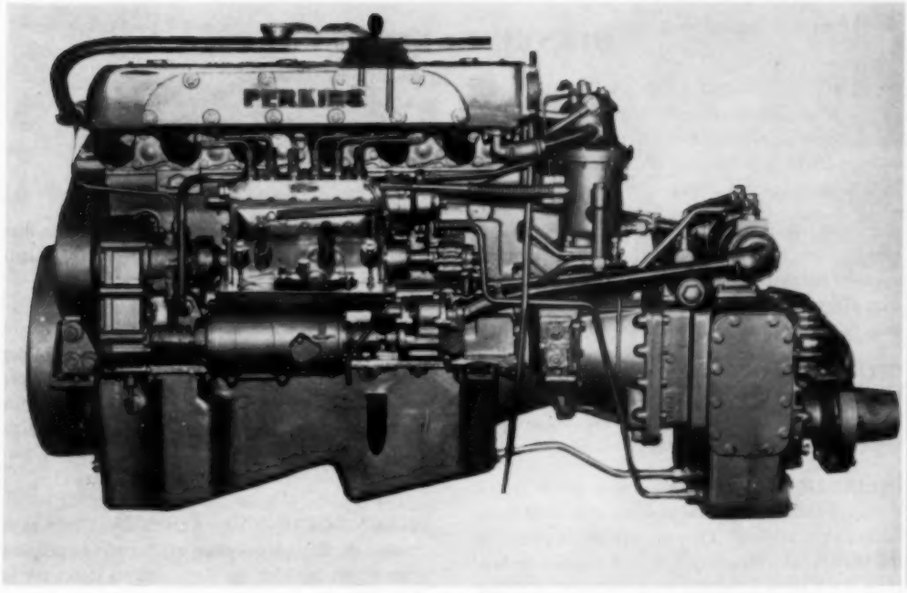


Figure 5

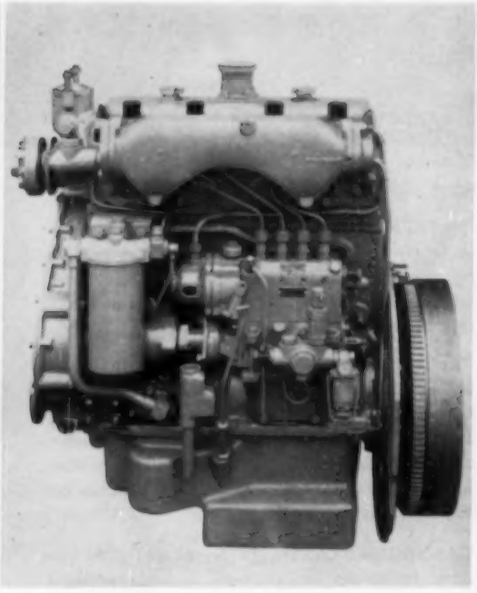


Figure 6

the bearing surfaces which are provided on each side of every cylinder. The main bearings are of copper lead carried in steel-backed shells. The connecting rods are steel, and the pistons light aluminum alloy or cast iron, according to engine speed requirements, with fully floated gudgeon pins. Each piston has three pressure rings, and two scraper rings.

The Hyster Company in the United States is offering Perkins 'P' series engines on the American domestic and export markets. For example, it is fitting the P6 diesel engine as an optional factory installation in its RC-SC series lift trucks, which have a 15,000-18,000 lbs capacity. Other manufacturers of industrial equipment in North America are also fitting Perkins engines. For two years, Perkins L4 engines have been supplied to Cockshutt Farm Equipment Ltd., of Brantford, Ontario, for installation in the Cockshutt 40 PD tractor.

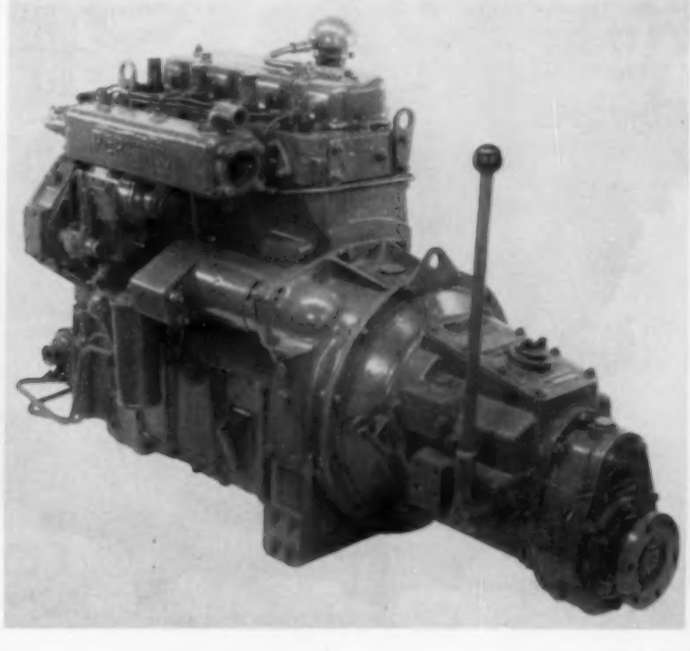
Features of the L4 include a low-level camshaft, easily replaceable pre-finished wet liners and crankshaft bearings. The crankshaft is made from an alloy steel stamping with hardened main and crankpin journals. The crankshaft is statically and dynamically balanced and runs in three pre-finished replaceable shell bearings, which are lead bronze lined. The camshaft and fuel pump are gear driven from the crankshaft. The timing case is a separate casting secured to the front end of the cylinder block. For agricultural applications the L4 will give powers up to 62 bhp.

Another engine produced by Perkins is the six-cylinder S6. Primarily designed as a marine engine, it has also industrial applications. The R6 Mark 2, largest vehicle engine in the wide range develops 104 bhp at 2,500 rpm and has a gross maximum torque of 240 lbs ft (33, 19 km) at 1,600 rpm. Designed for the medium tonnage vehicle, it is primarily intended for use in overseas countries where high commercial cruising speeds are required.

Both P6 and R6 vehicle engines are now being supplied on a production basis to North American truck manufacturers and are being offered by them as optional equipment in many overseas markets. Wherever Perkins engines operate, spares and service facilities are available. For Perkins have an associate company in France, subsidiary companies in Austrialia, South Africa and Canada. A network of distributors with Perkins-trained staff and strategically-placed company engineers are there to

Figure 7

Figure 8



NAPIER

DIESEL ENGINES

NAPIER Deltic engines are water cooled, opposed piston, compression-ignition engines operating on the 2-stroke cycle, the name being taken from the triangular arrangement of the three cylinder blocks.

The range comprises 18 and 9-cylinder industrial and marine versions designed for 5,000 hours duty between overhauls at continuous powers ranging from 860 to 1,725 h.p., and an 18 cylinder marine engine for high-speed craft, giving 2,500 maximum h.p. with a scheduled period of 1,000 hours between overhauls.

CRANKCASES AND MAIN BEARINGS—The three crankcases are arranged between adjacent cylinder blocks to form the triangular engine assembly, the six separate castings being secured together by high-tensile bolts which pass through both the crankcases and cylinder blocks, loading them in compression and taking all the combustion stresses.

Each crankcase is a one-piece alloy casting, substantially webbed and carrying a crankshaft in thin-wall lead-bronze, lead-plated indium-infused main bearings. Each bearing cap is secured by four studs, and additionally located by a tie-bolt which passes transversely through the cap and the crankcase walls on either side.

The two upper crankcases are identical, but the lower one is deepened in section to carry engine bearers, to provide effective oil drainage for the dry sump lubrication system, and to accommodate drives for the oil and water pumps.

CRANKSHAFTS—The crankshafts have hollow crankpins, are nitrided all over, and the bearing surfaces are finished by lapping. Each crankshaft is statically balanced and fitted with a viscous-type torsional vibration damper. The top crankshafts are identical and rotate in a clockwise direction viewed from full end; the bottom crankshaft has opposite-handed throws and rotates in an anti-clockwise direction to obtain the correct phase relationship.

CYLINDER BLOCKS—The three separate cylinder blocks are identical light alloy castings of monobloc construction with integrally-cast coolant passages, exhaust ports, and air inlet manifolds.

CYLINDER LINERS—The cylinder liners are of the open-ended 'wet' type and are machined from hollow steel forgings. They are chromium-plated in the bore, honeychrome etched, and finished by lapping. Each liner is located longitudinally by a ring nut which clamps a flange on one end of the liner against a shoulder in the bore of the cylinder block.

PISTONS—Each piston consists of two separate parts, an outer piston body of cast aluminum which has an unbroken skirt and carries the two top compression rings in an austenitic iron insert bonded to the aluminum by the 'Alfin' process, and an inner member which is machined from a 'Y' alloy forging; the latter carrying a fully-floating, hardened-steel gudgeon pin. When assembled these parts form passages, beneath the piston crown and behind the piston rings, in which lubricating oil is shaken by the piston motion and assists cooling.

CONNECTING RODS AND BEARINGS—Each crankpin carries a pair of connecting rods, one plain and one forked, on thin-wall, lead-bronze, lead-plated, indium-infused bearings. The exhaust pistons are attached to the forked rods which are reinforced by a nitrided steel bearing shell, the inner surface of which carries the thin-wall bearing for the crankpin; the inlet pistons are attached to the plain rods, which carry a thin-wall bearing that moves on the outside of the steel bearing shell between the legs of the fork.

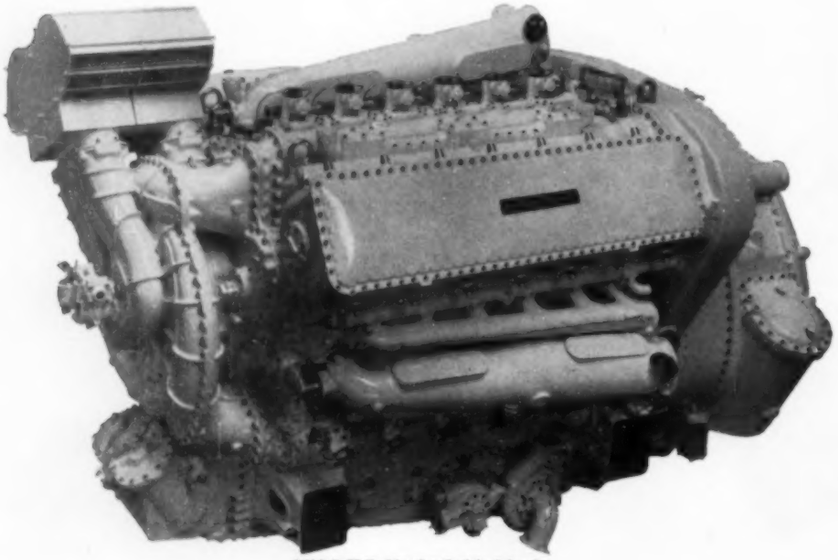
CAMSHAFTS—The 3 injection pump camshafts are enclosed by light alloy casings assembled to the outer face of the cylinder block. The camshafts are carried in phosphor-bronze bearings lined with white metal, and are driven from their respective crankshafts through short quillshafts which incorporate simple vernier timing adjustments.

PHASING GEAR—Power is transmitted from each crankshaft through coupling quill shafts to phasing gears which combine the three outputs into a single shaft, the direction of rotation of which is determined by the arrangement of the idler gears. The phasing gear also drives an ancillary power take-off shaft and the engine auxiliaries, except the fresh and sea-water pumps and oil pumps which are located on the bottom crankcase and driven through spur and bevel gears from the bottom crankshaft.

SCAVENGE AIR BLOWER—A single-stage double sided centrifugal blower, mounted on the free end of the engine and driven through flexible shafts from spur gears on the two top crankshafts, provides an air flow that completely scavenges the combustion chambers and provides a degree of supercharge. The blower and its driving gears form an independent unit that can be readily interchanged.

INJECTION SYSTEM—Fuel is supplied to the two nozzles in each cylinder by separate, constant-stroke, variable-delivery, fuel injection pumps. The pumps for each cylinder block are supplied with fuel from a common pressurized fuel line in a circulating system which precludes air locks. The design permits any one pump to be removed and replaced by another, correct timing and matching being automatically obtained.

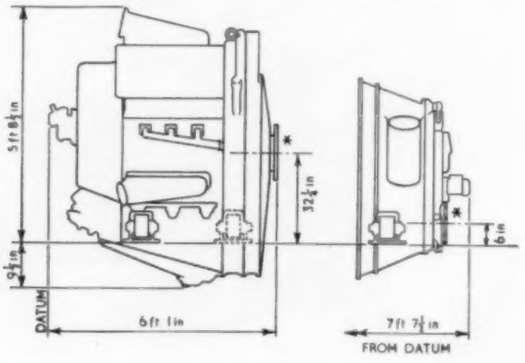
LUBRICATION SYSTEM—All bearings and gear trains throughout the engine are supplied with oil under pressure, the drain oil being returned to the tank by a scavenge pump. The dry sump system



2500 B.H.P. Napier Deltic Diesel.

Normal duty 9 cylinder engine without ahead-and-astern gearbox.

Ahead-and-astern gearbox for normal duty installation.



incorporates two full-flow filters, coupled in parallel. The single pressure pump supplies all services, including the metering pumps which control the flow to the blower bearings and to the sparge jets which spray the meshing points of the various gears.

Oil is taken from the crankshafts, through ducts in the connecting rods and gudgeon pin housings, to cool the pistons and is then discharged through drain holes to the crankcases.

EXHAUST SYSTEM—A water-cooled exhaust manifold is fitted to each cylinder block and all three manifolds are normally coupled to a common expansion tank, but other suitable agreed arrangements may be adopted. The temperature of the gas flow from each cylinder is measured by individual thermocouples fitted in the manifolds.

ENGINE COOLING—Cooling is effected mainly by a closed fresh water circulating system, but the heat transfer properties of the lubricating oil are also utilized. The fresh water and oil are both cooled by sea water through combined or separate heat exchangers. Thermostatic valves control the flows to the heat exchanger, employing by-pass circuits to maintain efficient running temperatures in the engine.

STARTER—A Coffman L6HP electrically-fired multi-breech combustion starter is normally employed for marine installations, but air or other starter units can be fitted.

AHEAD-AND-ASTERN GEARBOX (For Marine Propulsion Only)—The ahead-and-astern gearbox incorporates an hydraulically-operated friction clutch, which enables the engine to idle in neutral, or to drive ahead or astern through spur gears in constant mesh. Simultaneous selection of the required drive and the desired speed is made with a single control lever that moves over a quadrant from a central 'NEUTRAL' position to 'AHEAD' in one direction, or to 'ASTERN' in the other direction. The control system switches the clutch operating oil to the appropriate side of the hydraulic clutch in the gearbox and impresses the desired speed upon the hydraulic governor which relays it to the fuel controls after it has made allowances for engine load and running conditions.

The gear trains are lubricated and cooled by oil delivered through sparge jets from the engine lubrication system, and from an auxiliary pump that continues to supply oil when the engine is stopped if the gears are rotated by the propeller trailing.

Provision is made for starting an engine by running on another and 'trailing in.'

ENGINE MOUNTING—The light weight and even torque of the Deltic enables resilient mountings to be employed for carrying the engine, thereby completely damping vibrations to the bearers or structure and accommodating thermal expansion.

APPLICATIONS—The Deltic engine is suitable for all purposes in which low weight or small bulk is of importance. Its advantages are particularly apparent in the high speed motor boats for which it was originally designed, in multiple geared installations for merchant ships and in light weight transportable generating sets.

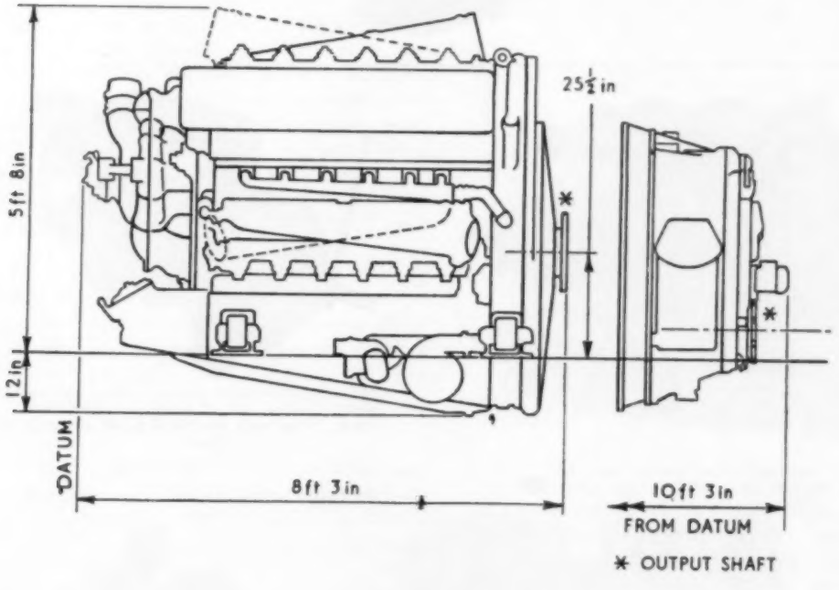
NAPIER DELTIC
2,500 b.h.p. DIESEL ENGINE
Section through No. 5 cylinder, viewed from driving end

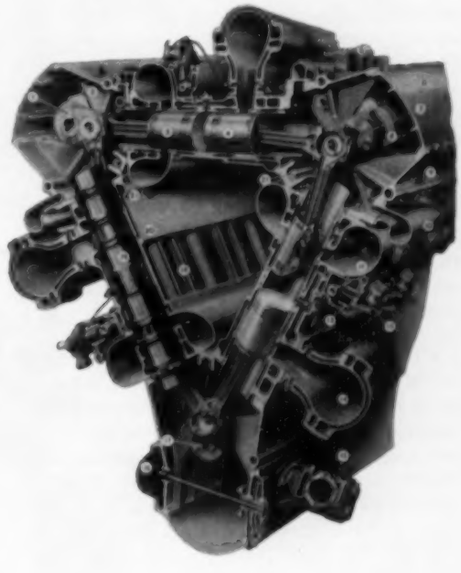
KEY

1 'BC' CRANKSHAFT
2 'BC' CRANKCASE
3 INLET PISTON
4 EXHAUST PISTON
5 CRANKCASE BREATHER
6 'AB' CRANKCASE
7 'AB' CRANKSHAFT
8 MAIN BEARING CAP
9 CRANKSHAFT TIE-BOLT
10 DRAIN OIL MANIFOLD
11 AIR INLET GALLERY
12 'A' CAMSHAFT CASING
13 FUEL INJECTION PUMP
14 EXHAUST MANIFOLD
15 SEA-WATER PUMP
16 FRESH-WATER PUMP AND PRESSURE OIL PUMP DRIVE GEAR
17 'CA' CRANKSHAFT
18 CYLINDER BLOCK TIE-BOLTS
19 CYLINDER LINER
20 'C' CYLINDER BLOCK
21 BLOWER FLEXIBLE DRIVE SHAFTS

18 CYLINDER ENGINE WITHOUT AHEAD-AND-ASTERN GEARBOX

AHEAD-AND-ASTERN GEARBOX FOR HIGH-SPEED CRAFT





Type of Engine	18 cylinder engine for High Speed Craft	18 cylinder engine for other purposes	9 cylinder engine for other purposes
B.H.P. (maximum)	2,500	.....	.....
B.H.P. (continuous)	1875	1650	860
Period between overhauls (hrs.)	1,000	5,000	5,000
Weight (without ahead/astern gearbox) (lb.)	.....	10,640	6,410
Weight (with ahead/astern gearbox) (lb.)	10,415	13,340	8,500
Bore (ins.)	5.125	5.125	5.125
Stroke (ins.)	7.25 x 2	7.25 x 2	7.25 x 2

BRUSH ABOE INC.

INDUSTRIAL, MARINE
RAIL TRACTION ENGINES
1½ TO 4,128 BHP

THE BRUSH GROUP OF COMPANIES distributes the products of its manufacturing subsidiaries in the U.S.A. and Alaska through BRUSH ABOE INC., New York. The power range of diesel equipment produced is from 1½ to 4,128 b.h.p., for industrial, marine and traction applications. There is also a range of dual-fuel engines from 62 b.h.p. at 750 r.p.m.

A notable feature of this closely integrated group of companies is its world-wide service of spares and replacements. This service is maintained through a network of strategically sited agents and the Group's own overseas companies.

The principal engine manufacturing subsidiaries of The Brush Group are Petters Limited, Mirrlees, Bickerton & Day Ltd., Vivian Engine Works, J. & H. McLaren Ltd. and The National Gas & Oil Engine Co. Ltd.

PETTERS LTD. manufacture a range of completely equipped aircooled and watercooled high speed Diesel four stroke engines, from 1½ to 12 b.h.p. at speeds up to 1800 r.p.m. The models illustrated have a bore and stroke measurement as follows: PAZ1 Bore 3″ (76.2 m.m.), stroke 3″ (76.2 m.m.); AVAIRMR Bore 3.15″ (80 m.m.), stroke 4.33″ (110 m.m.); AVA2 Bore 3.15″ (80 m.m.), stroke 4.33″ (110 m.m.).

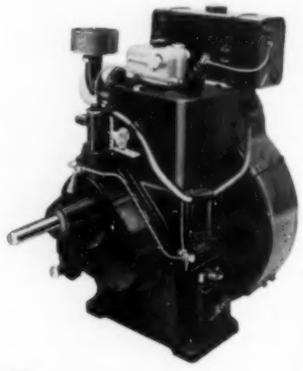
Their simple rugged design combines low cost with long reliable life. Maintenance is simple; the provision of a robust tunnel type crankcase with detachable main bearing housings at both ends, thin wall main and big-end bearings, renewable wet cylinder liners (in the watercooled engines), interchangeable parts and accessibility, provide for easy dismantling and replacement. On the twin cylinder engines, the centre main bearing is of thin wall type with a quickly detachable housing.

Pressure lubrication, to all bearings and valve gear, ensures a constant supply of oil and assists in internal cooling. A further refinement is the use of light alloy pistons with a chromium plated top ring which assists materially in reducing cylinder bore wear. Petters employ the direct injection, open combustion chamber system on all their diesel engines, thus ensuring easy starting throughout a wide temperature range.

The provision of five alternative drive arrangements makes the Petter Industrial Engines suitable for driving generators, pumps, refrigerators, elevators, marine auxiliaries, crop driers, mixers, etc. An S.A.E. flange mounting adaptor is also available.

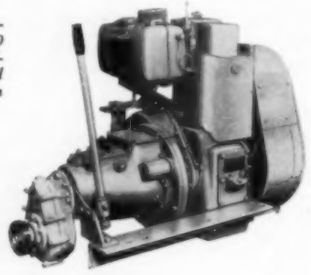
J. & H. McLAREN LTD. manufacture the McLaren 'M' series of medium speed diesel engines which have achieved a world wide reputation for efficiency and trouble free running in an extensive range of industrial and marine applications. The 'M' series is produced in 2, 3, 4, 5, 6 and 8 cylinder forms with a power range of 33 to 200 b.h.p. at 750 to 1200 r.p.m. The cylinder bore is 5.59 ins. (142 m.m.) and the piston stroke 7.874 ins. (200 m.m.).

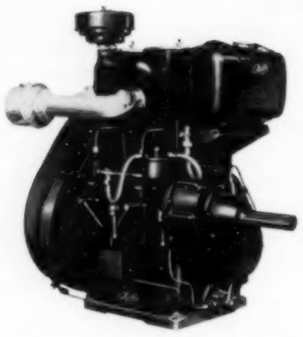
Petter-McLaren B type diesel engines are manufactured in a range of 2, 3 and 4 cylinder engines, from 13 to 48 b.h.p. at 1000 to 1800 r.p.m. Bore 4.33″ (110 m.m.) Stroke 4.33″ (110 m.m.). They are suitable for all purposes within their power range, including marine propulsion. The B engine is outstandingly adaptable and a half speed takeoff shaft is available on the 2- 3-cyl. engines.



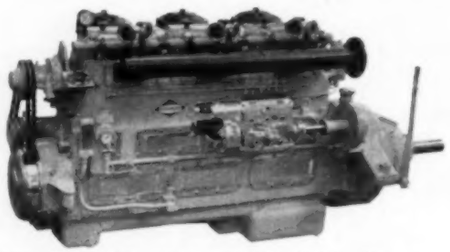
PAZ1 Industrial Diesel Engine. 1½/3 b.h.p., 1000/1800 r.p.m. Single Cylinder Air-cooled.

AVAIRMR Marine Diesel Propulsion Engine. 6 b.h.p. 1800 r.p.m. Single Cylinder Air-cooled, Alternative Rotation, fitted with Reverse and 2:1 Reduction Gear.





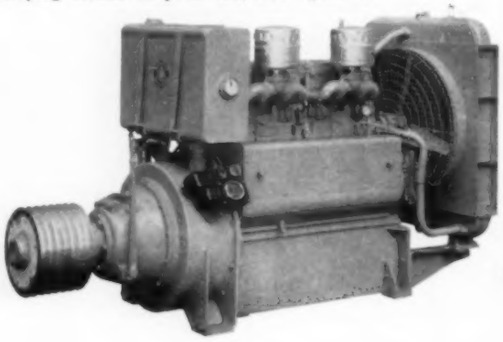
AVA2 Industrial Diesel Engine. 6/12 b.h.p., 1000/1800 r.p.m. Twin Cylinder, Air-cooled, Alternative Rotation.



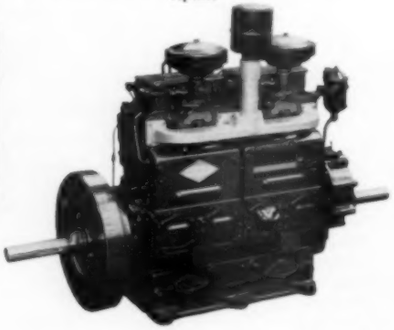
LE6 lightweight diesel, 100/180 b.h.p., 1000/1800 r.p.m.

PD4 Aircooled four cylinder diesel engine which develops 26/48 b.h.p. at 1000/1800 r.p.m. Fitted with Rockford hand operated clutch.

M4 self contained diesel power unit developing 66/100 b.h.p. at 750/1200 r.p.m.



B4 Diesel engine, 26/40 b.h.p., 1000/1500 r.p.m.



The Petters-McLaren PD and PDV AIR-COOLED engines represent results of extensive development work and are of advanced design.

Aircooling eliminates all the problems involved in the installation and maintenance of water cooled systems and the Petter-McLaren PD Aircooled engine can operate in any extreme of climate without fear of overheating in tropical conditions, or cylinder block breakages due to cold weather when working in Arctic zones. The range consists of the 2, 3 and 4 cylinder in-line engines and the Vee form 6 and 8 cylinder engines, from 13 to 96 b.h.p. at 1000 to 1800 r.p.m. The cylinder bore for PD and PDV engines is 4.5″ (114.3 m.m.) and the stroke 4.33″ (110 m.m.).

The most recent addition to the Petter-McLaren range of diesel engines is the LE Series of lightweight diesels with a power rating of from 66 to 180 b.h.p. normally aspirated and from 88 to 240 b.h.p. supercharged. The cylinder bore being 5⅝″ (142.9 m.m.) and stroke 6″ (152.4 m.m.).

MIRRLEES, BICKERTON AND DAY LTD. produce three types of diesel engine, the TL, J and K, which give an overall power range from 111 to 4,128 b.h.p. Mirrlees products are thoroughly reliable, robust, and economical and are suitable for power generation, industrial uses, oil field applications, main line and shunting locomotives, mobile and semi-mobile power packs, land drainage schemes and marine propulsion and auxiliary duties.

The TL range is produced in 3 to 6 cylinders, naturally aspirated and with 6 cylinders, turbo-charged. Normal running speed is 600 r.p.m. The bore for 3, 4 and 5 cylinder engines is 8½″ (215.9 m.m.) and the stroke 13¾″ (349.2 m.m.). In the case of the 6 cylinder engine the bore is 8½″ (215.9 m.m.) and the stroke is 13″ (330.2 m.m.). The J range is produced from 3 to 8 cylinder in-line and in 8, 12 and 16 cylinders vee-form, naturally aspirated, turbo-charged or turbo-charged with air coolers. The engines run at speeds between 400 and 900 r.p.m. The cylinder bore is 9¾″ (247.6 m.m.) and stroke 10½″ (266.7 mm.).

The largest engines are in the K range. They are from 3 to 8 cylinders in-line and in 12 and 16 cylinders vee-form, and are available naturally aspirated, turbo-charged or turbo-charged with air coolers. They run at speeds from 200 to 450 r.p.m. The cylinder bore is 15″ (381.0 m.m.) and the stroke 18″ (457.2 m.m.).

All Mirrlees engines have a high bore/stroke ratio which ensures reliability and long life because the piston speed is kept to a comparatively low figure. The use of four-valve cylinder heads permits maximum volumetric efficiency to be obtained, a higher degree of cylinder scavenging and consequently, greater output per unit swept volume.

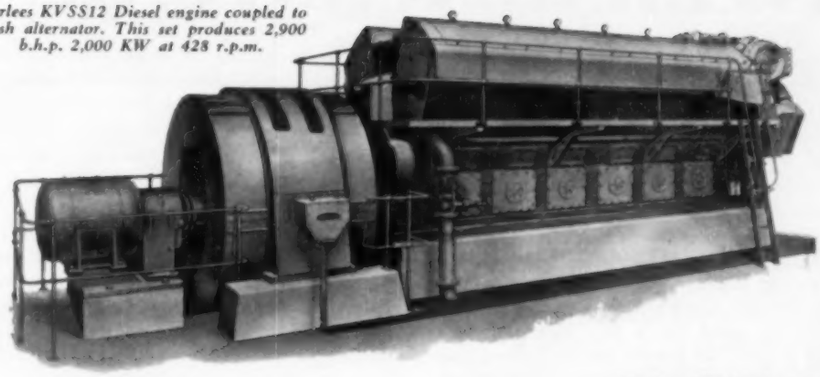
Designed to meet the growing trend for power units of compact size, these engines maintain the essentials of low piston speeds, robust construction and ease of accessibility.

NATIONAL GAS AND OIL ENGINE CO. LTD. produce a range of diesel and dual-fuel engines from 3 to 2,000 b.h.p. There are four main series of vertical engines: the M type employing 3 to 8 cylinders, bore 6″ (152.4 m.m.) and stroke 8½″ (215.9 m.m.); the R type employing 3 to 8 cylinders, bore 9″ (228.6 m.m.) and stroke 12″ (304.8 m.m.); the F type employing 3 to 8 cylinders, bore 12″ (304.8 m.m.) and stroke 15″ (381.0 m.m.); the B type with 5 to 8 cylinders, bore 17″ (431.8 m.m.) and stroke 21½″ (540.9 m.m.). All these are made in normally aspirated and pressure-charged versions. They are available for industrial and rail traction purposes and as marine propulsion units, driving through oil operated gear boxes.

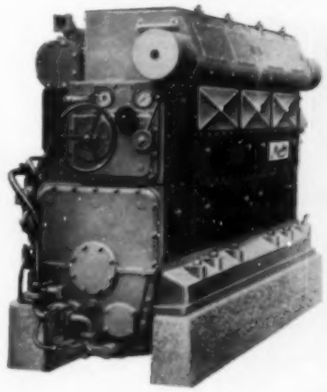
The National Gas and Oil Engine Co. Ltd. have always been in the forefront of research and have a wealth of experience in dealing with problems of combustion, valve positioning, port flow and the distribution of thermal stresses. Consequently the four-valve cylinder head and open combustion chamber designs in current use are those which enable the utmost power to be gained from the amount of fuel supplied.

Manufacture of National M type engines in North America is undertaken by the Vivian Diesel and Munition Co. Ltd., Canada. This Brush Group company maintains National's traditions of service, craftsmanship and all round dependability.

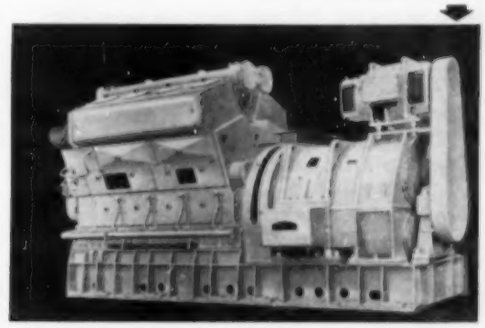
Mirrlees KVSS12 Diesel engine coupled to Brush alternator. This set produces 2,900 b.h.p. 2,000 KW at 428 r.p.m.



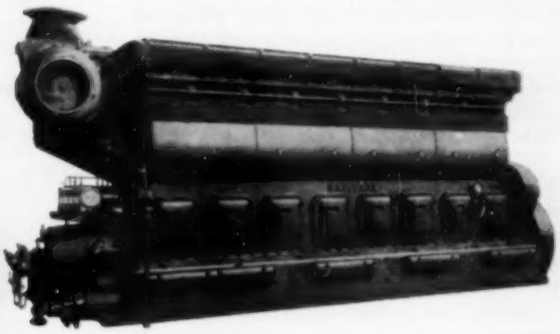
Mirrlees J6 engine. 6 cylinders, in line, normally aspirated 420 b.h.p. at 750 r.p.m.



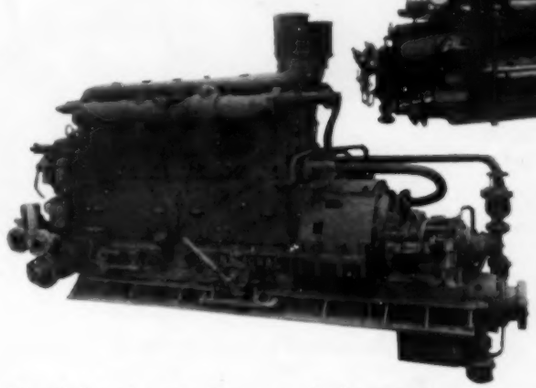
Mirrlees JV8 Marine Auxiliary engine having a normal 12 hour rating of 560 b.h.p. at 750 r.p.m. coupled to a special generator of Brush manufacture 375 KW. D.C.



National F4AU8 type pressure-charged Diesel engine; 1040 b.h.p., 500 r.p.m.



National M4AAM6 marine propulsion engine and oil operated gearbox 225 b.h.p./205 s.h.p. at 1400 r.p.m.



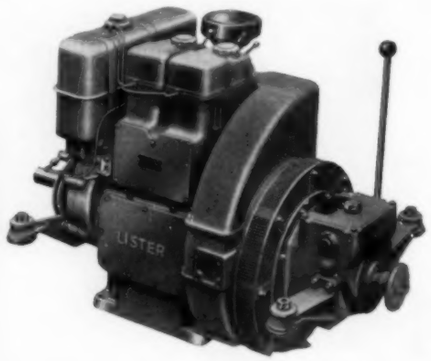
LISTER-BLACKSTONE

DISTRIBUTION of Lister-Blackstone Engines for the United States is handled by a subsidiary company, Lister-Blackstone Inc., 42-32 21st Street, Long Island City 1, New York, thus permitting of the closet possible contact between the maker and the distributor. Engines are shipped to the United States less such units as starters, generators, radiators, clutches, marine gears, etc. The corresponding American made accessories are used, thus simplifying spares problems. Comprehensive stocks of engines and spare parts are carried by Lister-Blackstone Inc., New York, and its distributors. The Lister line of engines is built in a range of sizes from 3 to 77 bhp, and is offered for both industrial and marine application.

Type LD Air Cooled Engines. 1½-7 H.P.

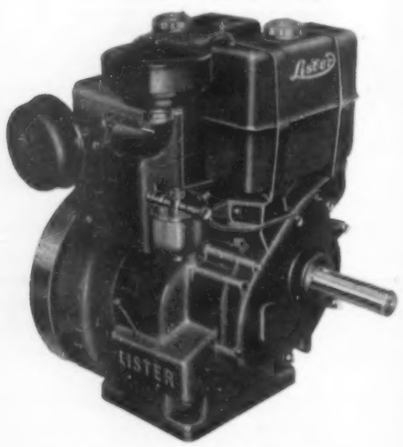
Offered as single or twin cylinder models, the type LD Engines are reliable, compact and efficient. Designed as they are for the most arduous marine and industrial duties, these engines incorporate many features which make them outstanding in their class. Economic running and easy starting are ensured by the combination of a single-hole pintle type injector nozzle with a combustion chamber located in the piston crown. In addition to ensure easy starting under extreme climatic conditions the engines are fitted with a cold starting oil injection device.

A plunger type lubricating oil pump in conjunction with a hydraulic accumulator assures a constant supply of oil under pressure to main bearings, connecting rod big end bearings and valve rocker gear. The main and big end bearings are of the shell type, ensuring ease of maintenance and replacement. The centrifugal governor maintains the settled variation of revolutions within 3%. Engines can be supplied with SAE No. 5 and SAE No. 6. adaptors suitable for close coupling American machinery. The engines are ideally suitable for driving machinery such as compressors, pumps, generating plant, concrete mixers and other contractors plant.



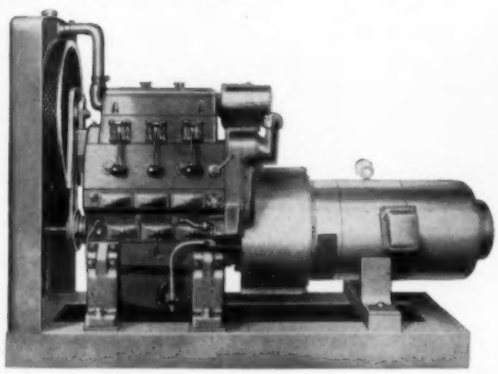
Model LD2MGR - twin cylinder air-cooled marine propulsion engine fitted with epicyclic reverse gear.

Model FR4 with Snow-Nabstedt reverse and reduction gears.



Model LD1-1½ hp at 800 rpm to 3½ hp at 1800 rpm. Provision for power take-off both from crankshaft and from half-speed shaft.

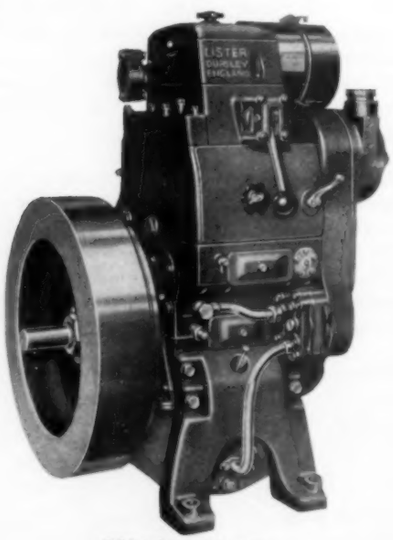
FR3 skid mounted generator set with electric starting.



FR Range. 9-54 H.P.

The FR range of engines incorporates single, twin, three, four and six cylinder models, water cooled, and developing 9 hp per cylinder at 1800 rpm. All working parts are totally enclosed for protection, but the fitting of easily removable doors and cover plates ensures easy maintenance and accessibility. FR Engines are fitted with the patented Lister dual combustion chamber, which allows the compression ratio to be raised for starting and then lowered for normal running on load. Thus the engines can be started under extremely cold conditions and at high altitudes.

The engines have been designed for maximum interchangeability of parts. The cylinder liners, which are removable, are treated with the Listard process of chrome hardening, which gives the maximum resistance to wear. The bearings, which are also interchangeable throughout the range, are of the steel-back precision type. The fuel filter on all FR engines is contained in a built-in settling chamber incorporated in the crankcase. The centrifugal governor gives a settled speed variation of not more than 2%. The governor and all auxiliary components are driven from one train of gears grouped in a housing at the end of the engine. FR engines can be supplied with SAE No. 1, SAE No. 2, or SAE No. 4 flywheel housings and are suitable for driving welding and generating plants, pumps, excavators, road making machinery, concrete mixers etc. The engines are also equally suitable for marine auxiliary and propulsion applications as the robust nature of their design ensures continuous trouble-free operation.



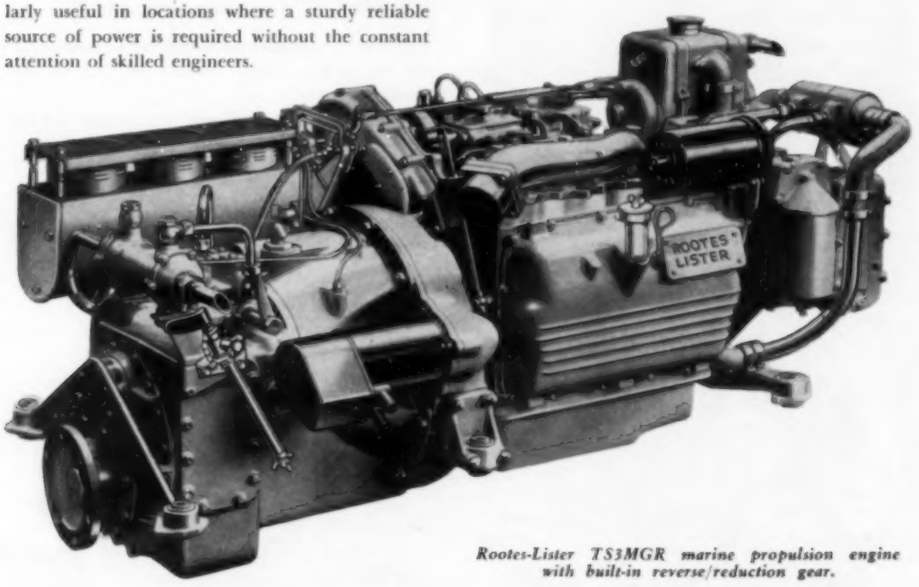
FR1-9 hp, 1800 rpm.

21/2, 30/3, 40/4 and 616 Engines. 21-62 B.H.P.

These twin, three, four and six cylinder engines operate at a maximum speed of 1200 rpm. The engines incorporate the Lister dual combustion chamber and are consequently out-standing in their readiness to start from cold. The replaceable cylinder liners are treated with the Listard chrome hardening process, thus offering maximum resistance to wear. The engines are available with either electric or air starting and carry a reputation for reliability in both marine and industrial applications. When supplied as marine engines the units are fitted with dry sump lubrication. Lubrication is supplied by a forced feed to the main bearings, big end bearings and camshaft. The simplicity in construction and ease of maintenance are particularly useful in locations where a sturdy reliable source of power is required without the constant attention of skilled engineers.

3½/1. 6/1 and 12/2 Engines 3½ - 12 H.P.

These vertical water cooled engines operate at a maximum speed of 650 rpm. Like the range of engines described above, these engines are fitted with the Lister dual combustion chamber and the cylinders are treated with the Listard chrome hardening process. Lubrication is carried to the main bearings by means of a pump feed; splash to other working parts. The cooling is carried out by the thermo syphon principle. The engines are ideally suited for agricultural and industrial application. When supplied for electrical applications the engines are fitted with special heavy flywheels in order to reduce the cyclic irregularity to the required level.



Rootes-Lister TS3MGR marine propulsion engine with built-in reverse/reduction gear.

Rootes-Lister TS3 Engines - 77 H.P.

The TS3 diesel engine was designed by the Rootes Group. Its application for industrial purposes has been carried out in conjunction with R. A. Lister & Co. Limited, and the marine application has been carried out by Lister-Blackstone Marine Limited, both for propulsion and auxiliary purposes. The TS3 engine is a horizontally opposed, 3 cylinder, two stroke engine, with blower-assisted scavenge. The exceptionally high thermal and mechanical efficiencies give a power to weight ratio of 1.13 for the industrial unit. The outstanding feature of this engine is the simplicity in design. Working parts are readily accessible. Maintenance can be carried out with a minimum of difficulty.

The crankshaft is mounted below the cylinders and the power transmission from pistons to crankshaft is carried through a rocker linkage. The small angularity of the piston linkage reduces side thrust on the cylinder walls to a minimum, thus reducing the wear accordingly. Conventional valves are replaced by a belt of inlet and exhaust ports in each cylinder barrel, the design of which ensures a thorough scavenging and effective re-charging of the cylinders. This is further ensured by the Roots type 3-lobe blower which is mechanically driven. The overall height of the TS3 industrial engine (without radiator) of only 2'6" and the simplicity and compactness of the engine make it ideally suitable for marine and industrial application. The industrial engine is normally supplied as a power pack unit with either temperate or tropical radiator. The normal power take-off is through a clutch, but an extension shaft is available for direct or pulley drive when required.

LISTER DIESELS

LISTER-BLACKSTONE, INC., 42-32 21st Street, Long Island City 1, N. Y.

Model	Cycle	Max. Gross B.H.P.	Rated B.H.P.	Cylinders	Bore & Stroke	R.P.M.	Fuel System	Application	Weight (Approx.) lbs.	Starting
LD1	4	5	3.5	1	3 x 3½	1800	Bosch CAV	S or M	245	H-EL
LD2	4	10	7	2	3 x 3½	1800	Bosch CAV	S or M	406	H-EL
3½-1	4	4.85	3.5	1	3¾ x 5½	650	Bosch CAV	S	692	H
6-1	4	7.3	6	1	4½ x 5½	650	Bosch "	S	692	H
12-2	4	14.6	12	2	4½ x 5½	650	Bosch "	S	1040	H
21-2	4	27	20.5	2	4½ x 5½	1200	Bosch "	S or M	1585	H-A-EL
30-3	4	41	30	3	4½ x 5½	1200	Bosch "	S or M	2042	H-A-EL
40-4	4	52	38.7	4	4½ x 5½	1200	Bosch "	S or M	2536	H-A-EL
61-6	4	80	62	6	4½ x 5½	1200	Bosch "	S or M	3234	A-EL
FR1	4	13	9	1	3¾ x 4½	1800	Bosch "	S or M	795	H-EL
FR2	4	26	18	2	3¾ x 4½	1800	Bosch "	S or M	977	H-EL
FR3	4	39	27	3	3¾ x 4½	1800	Bosch "	S or M	1164	H-EL
FR4	4	52	36	4	3¾ x 4½	1800	Bosch "	S or M	1370	H-EL*
FR6	4	78	54	6	3¾ x 4½	1800	Bosch "	S or M	1660	H-EL*
TS3	2	101.5	77	3	3¼ x 4x2	1800	Bosch "	S or M	1000	EL*

Application: S—Stationary; M—Marine. Starting: H-Hand; A-Air; EL-Electric. *Electric Starting equipment standard on FR-4, FR-6, and TS-3.

Note. 1. Max. Gross B.H.P. is the B.H.P.* which the engines develop on the dynamometer without driving any power-consuming accessories or auxiliaries.

2. Rated B.H.P. is the B.H.P. which the engines develop for 12 hours daily at the rated speed at altitudes up to 500ft above sea level and ambient temperatures up to 85° F. 3½/1, 6/1 and 12/2 engines are rated for 8 hours daily, at the rated speed, at altitudes up to 350 ft above sea level and ambient temperatures up to 65° F.

MERCEDES-BENZ

LIQUID COOLED FOUR CYCLE DIESELS

MERCEDES-BENZ DIESELS"a full line of diesel engines for all purposes, produced by Daimler-Benz A. G. They are all liquid cooled four-cycle engines, ranging from 15 to 3000 HP. All are built with the patented pre-combustion chamber, which assures low firing pressure, smokeless combustion in all speed ranges as well as insensitiveness against changing quality of the used fuel. It also provides maximum quietness under all load conditions and at all speeds, at the same time giving maximum engine output at lowest fuel consumption.

For starting, glow plugs are used, which allow, after pre-glowing, direct starting on normal fuel. The liquid cooled engines are all thermo-statically controlled and therefore kept at the most efficient temperature. Operational security and maximum effectiveness is therefore guaranteed even under extreme climatic conditions. The rugged construction gives them highest dependability, simple operation and low maintenance costs, and a very extended service life. The extensive use of light metal alloys has made the engines very light, which permits their use practically everywhere. At the same time their overall dimensions are small, due to a very compact construction.

The line of Diesel engines can be divided into the following types:

1-cylinder, small, for stationary use only, 25 HP	MB 841 B
2 to 4-cylinder, ranging from 55 to 120 HP, for stationary, automotive, rail or maritime use	MB 202 B MB 203 B MB 204 B
4 and 6-cylinder, high speed, ranging from 34 to 150 HP for use mainly in the automotive line, but adaptable for all uses. Two types available with turbo-charger	OM 636 OM 312 OM 315 OM 321 OM 312 OM 315 A
6-cylinder vertical, ranging from 225 to 350 HP for use as stationary, mobile or marine power available with turbo-charger and high-stage turbo-charger	MB 846 A MB 846 Ab MB 846 Db
6-cylinder horizontal, ranging from 225 to 300 HP for use in automotive rail. Available with turbo-charger	MB 846 B MB 846 Bb
6-cylinder vertical, ranging from 350 to 650 HP for use as stationary, mobile or marine power. Available with turbo-charger and high-stage turbo-charger	MB 836 B MB 836 Bb MB 836 Db
12-cylinder V, ranging from 700 to 1350 HP for use as stationary, mobile or marine power. Available with turbo-charger and high-speed turbo-charger	MB 820 B MB 820 Bb MB 820 Bb
These engines consist to a large extent of the same parts, which are interchangeable.	
8-cylinder V, output 480 to 600 HP for use as automotive, mobile or marine use. Available with supercharger	MB 837 A MB 837 Aa
20-cylinder V, output 3000 HP with supercharger, for use as marine power.	MB 518

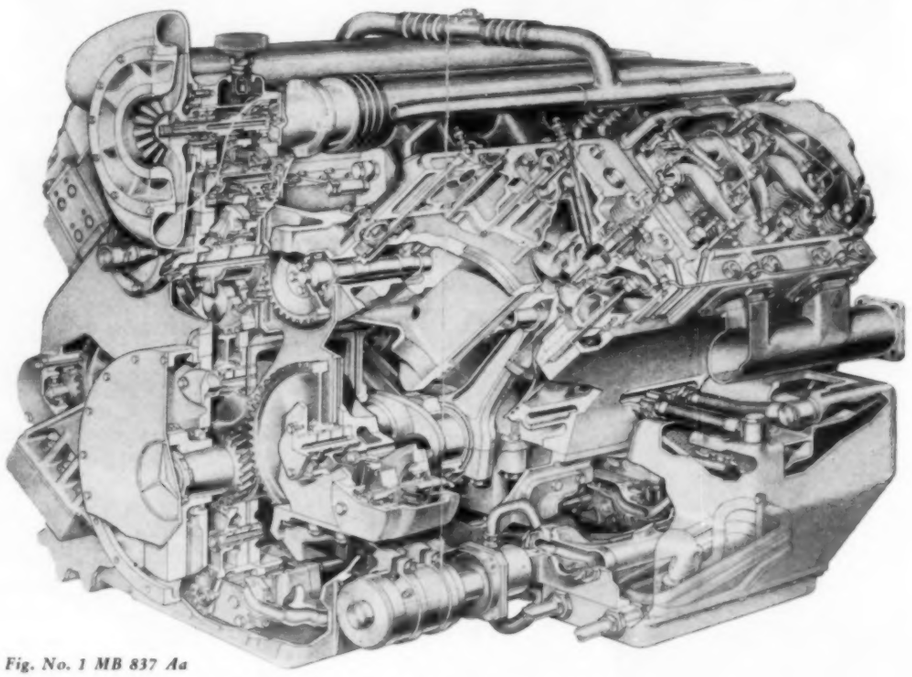
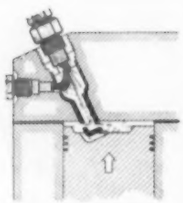


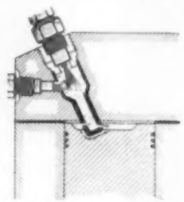
Fig. No. 1 MB 837 Aa

Combustion within the pre-combustion chamber of the MERCEDES-BENZ Diesel engine

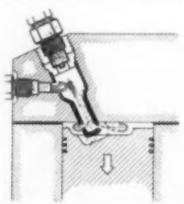
The pre-combustion chamber system as patented by Daimler-Benz A. G., allows a better utilization of air in connection with high break mean effective pressure and low firing pressure.



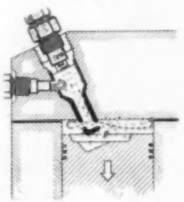
At the moment of the highest compression, the injection occurs into the pre-combustion chamber.



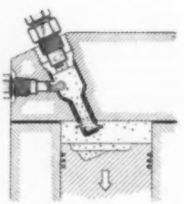
The injected fuel is ignited by the heated air in the pre-combustion chamber.



The pressure created by the ignition forces the contents of the pre-combustion chamber into the main combustion chamber through diagonally arranged openings.



The created intensive turbulence guarantees an even and complete combustion without residues, which in addition is decisive for the smokeless exhaust.



Aproximately 30° after top dead center the actual combustion is over. The expansion of the gases forces the piston down.

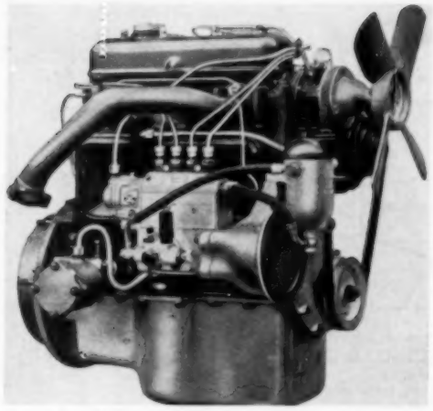
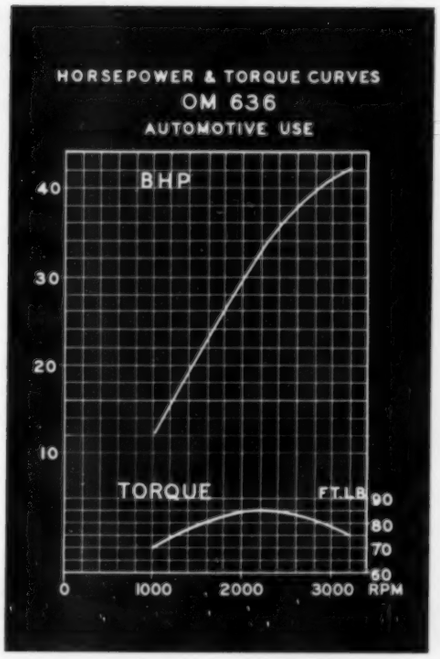


Fig. No. 7 OM 636 Automotive engine.



Characteristics Of The OM 636

4-cylinders in-line.

Engine block:	Special chrome-nickel alloy cast-iron, extending from oil pan to cylinder head.
Cylinder head:	Special casting, one piece for all 4 cylinders.
Valves:	One intake, one exhaust per cylinder, over-head operated via rocker arms, tappets and push rods from camshaft; high quality steel.
Pre-combustion chamber:	Exchangeable.
Burner:	Removable, in two parts.
Injection nozzle:	Make: Robert Bosch
Injection pump:	Make: Robert Bosch
Pistons:	Light metal alloy, 3 compression-, 2 oil rings.
Piston pins:	Floating; steel case-hardened.
Connecting rods:	Forged, heat treated.
Crankshaft bearings:	Main: lead bronze (3) in two half-shells.
Connecting rods bearings:	Lead bronze in two half-shells.
Camshaft:	Forged, supported in 3 removable bushing type bearings.
Oil pan:	Light metal casting.
Oil pump:	Gear pump, driven by helical gear from crankshaft.
Lubrication:	Forced feed.
Waterpump:	Centrifugal type, V-belt driven.

This engine is used extensively in the automotive field and is the power plant for the well-known Mercedes-Benz "Model 180 D", as well as for the well-known "all-purpose vehicle" UNIMOG. Outside of the standard installation in these two vehicles, it has been used for all kinds of industrial purposes, as marine engine, and for generators, pumps, air compressors, and oil drilling rigs.
Its special qualities are: high performance, low weight, small required space, absolute operational safety, great economy, long service life, easy maintenance.

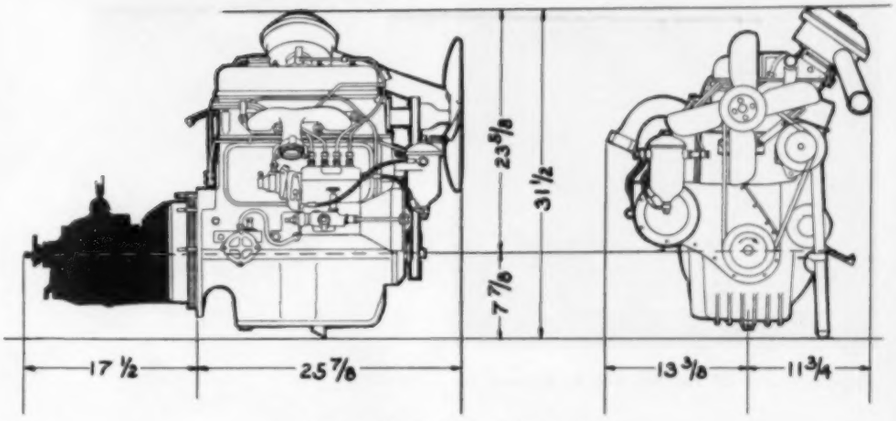


Fig. No. 8 OM 636 Automotive engine

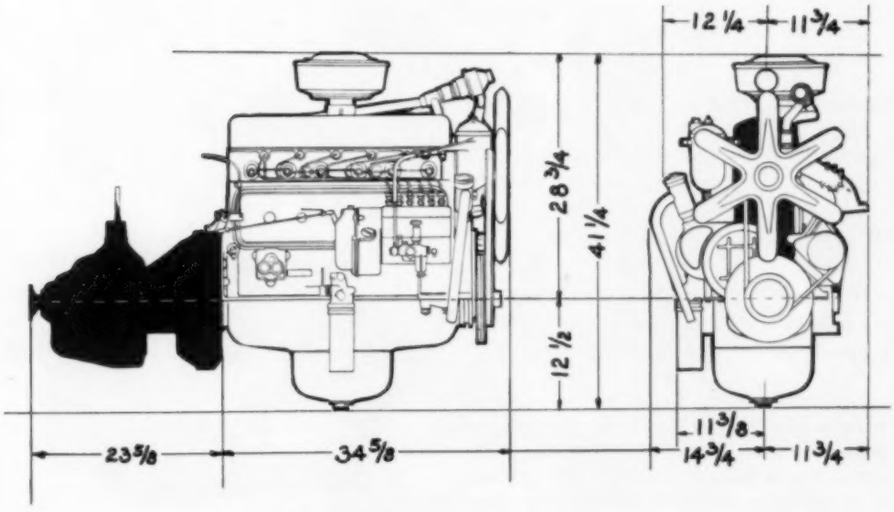
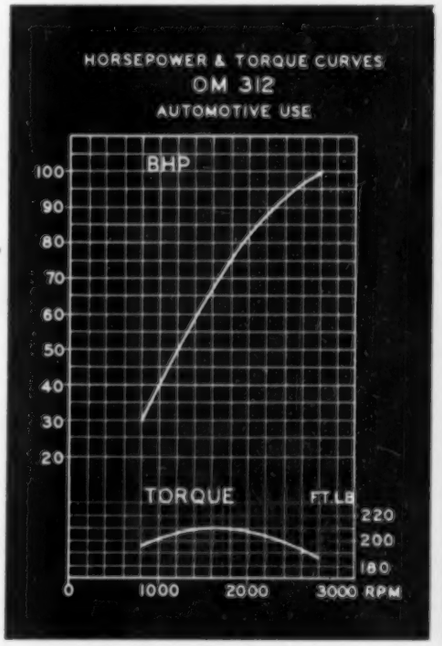


Fig. No. 9 OM 312 Automotive engine



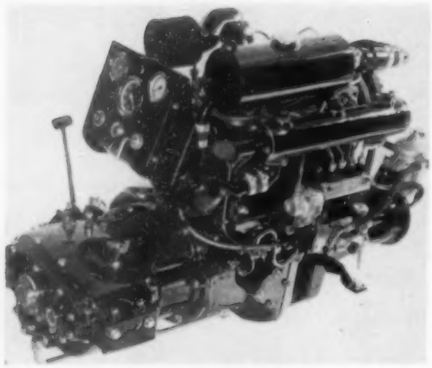
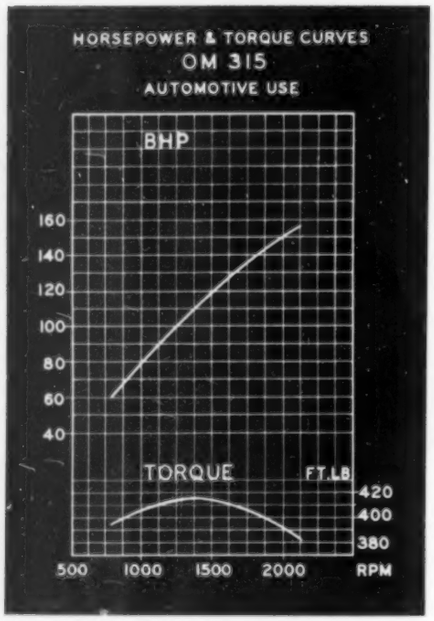


Fig. No. 10 OM 636 with special transmission



Characteristics Of The MB 846 A, Ab and Db

6-cylinders in line, vertical, available with turbo charger, high-turbo charger and after cooler.

Engine block:	Crankcase and block an integral casting of special alloy.
Cylinder liners:	Wet liners, special centrifugal casting, exchangeable.
Cylinder heads:	Special cast iron, individual for each cylinder.
Valves:	1 intake, 1 exhaust valve per cylinder, overhead, special heat resistant steel.
Pre-combustion chamber:	Exchangeable.
Burner:	Multi-opening, cup-shaped burner.
Rocker arms:	Activated via tappets and push rods.
Pistons:	Light metal alloy, 3 compression-, 2 oil rings.
Piston pins:	Floating, steel casehardened.
Connecting rods:	Alloy steel.
Crankshaft:	Heat treated alloy steel.
Crankshaft bearings:	Main: steel backed half-shell lead bronze bearings, 6 friction, 1 thrust.
Connecting rod bearings:	Steel backed half-shell lead bronze bearings.
Camshaft:	Special steel, supported in 7 removable bushing-type bearings.
Oil pan:	Light metal casting.
Oil pump:	Gear pump.
Water pump:	Centrifugal type, gear driven.
For model Ab:	Turbo charger, Make: BBC
For model Db:	High-stage turbo charger with air cooler.

These engines are used largely in rail service, as power for locomotives, railcars and others, in ships and yachts, as stationary or mobile power units, or as driving power for generators, compressors, pumps etc.

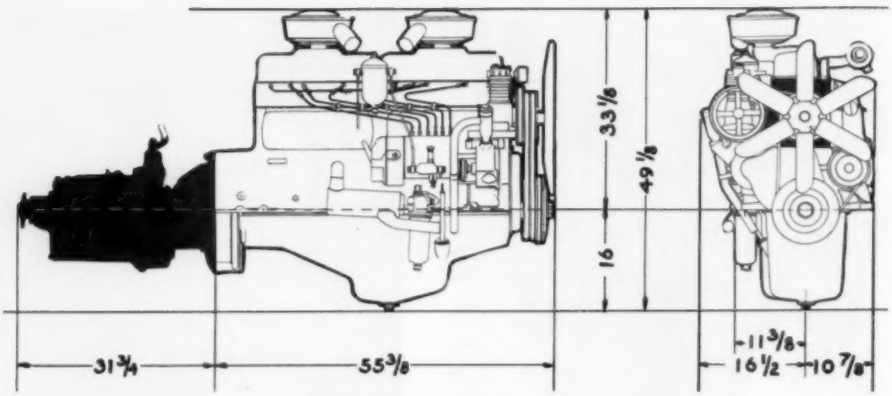


Fig. No. 11 OM 315 Automotive engine

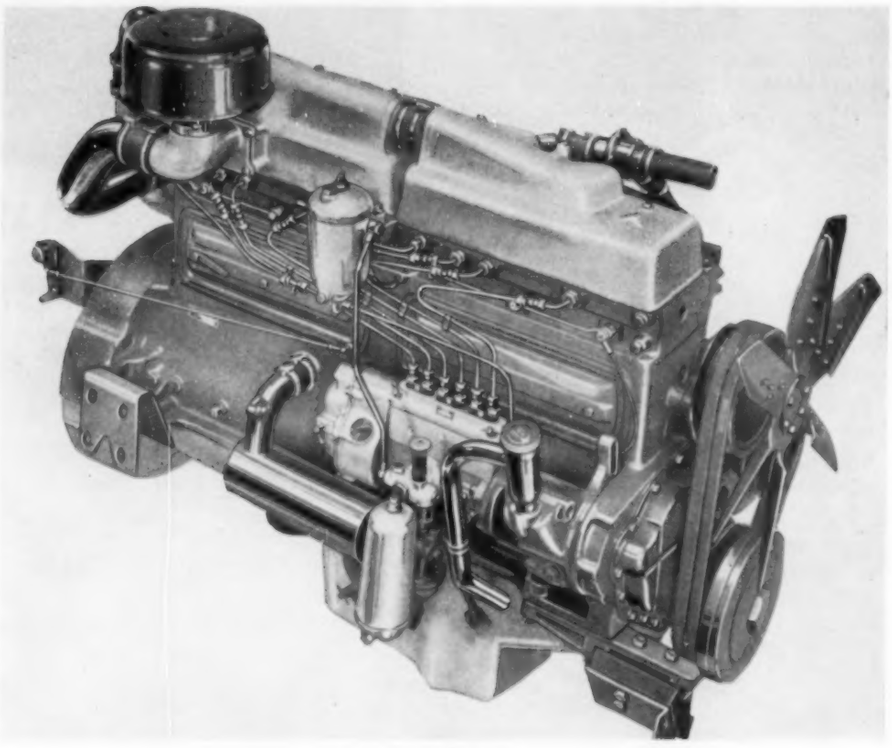


Fig. No. 12 OM 315 A

The components of these engines are identical and therefore interchangeable.

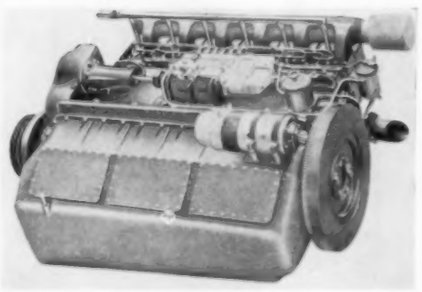


Fig. No. 13 MB 846 B

Characteristics Of The MB 836 B, Bb and Db MB 820 B, Bb and Db

MB 836 B, Bb and Db—6-cylinders in line, vertical, available with turbo charger and high turbo charger with after cooler.

MB 820 B, Bb and Db—12-cylinders in V, (2 x 6 in line) available with turbo charger and high turbo charger with after cooler.

Engine block:	Crankcase and block an integral casting of special light metal alloy.
Cylinder liners:	Wet liners, special centrifugal castings, exchangeable.
Cylinder heads:	Special cast iron, individual for each cylinder.
Valves:	2 intake, 2 exhaust valves per cylinder, overhead, special heat resistant steel.
Pre-combustion chamber:	Exchangeable.
Burner:	Multi-opening, cup-shaped burner.
Rocker arms:	Activated via tappets and push rods.
Pistons:	Light metal alloy, 3 compression-, 2 oil rings.
Piston pins:	Floating, nitrated steel.
Connecting rods:	Alloy steel.
Crankshaft:	Heat treated alloy steel.
Crankshaft bearing:	Main: Steel backed half-shell lead bronze bearings, 6 friction, 1 thrust.
Connecting rod bearings:	Steel-backed half-shell lead bronze bearings.
Camshaft:	Special steel, supported in removable bushing-type bearings.
Oil pan:	Light metal casting.
Oil pump:	Gear pump.
Water pump:	Centrifugal type, gear driven.
For models:	BM 836 Bb and MB 820 Bb: Turbo charger Make BBC.
For models:	MB 836 Db and MB820 Db: high turbo charger with after cooler.

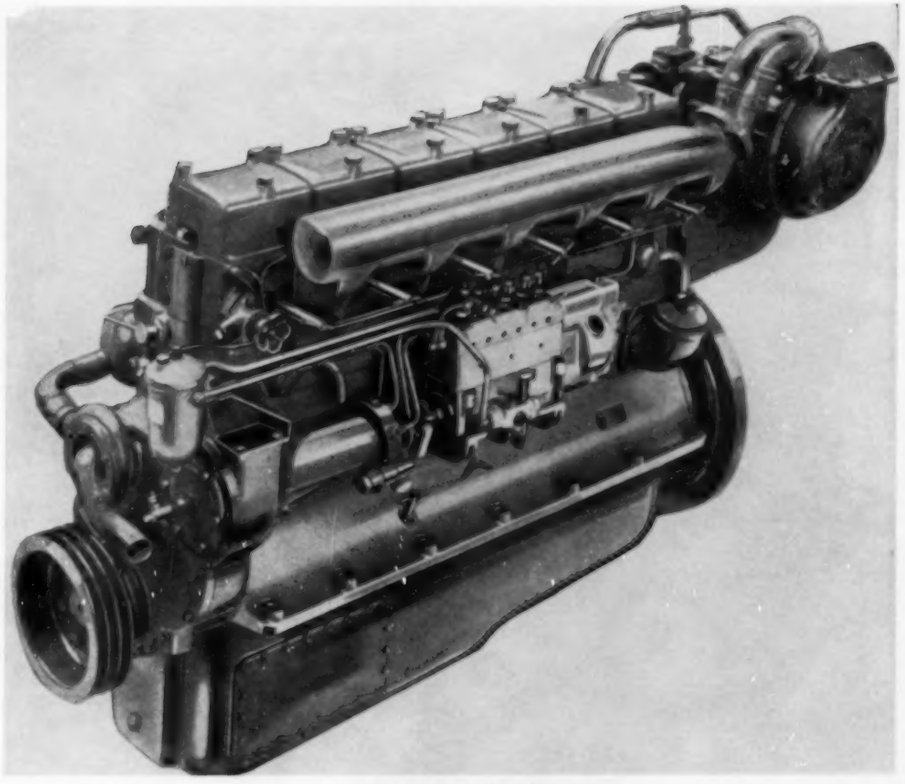


Fig. No. 14 MB 846 Ab

Above engines are used in industrial power plants, railbound vehicles, ships and boats as main or auxiliary power, generators, pumps, compressors, and many others.

The components of the above engines are identical and interchangeable.

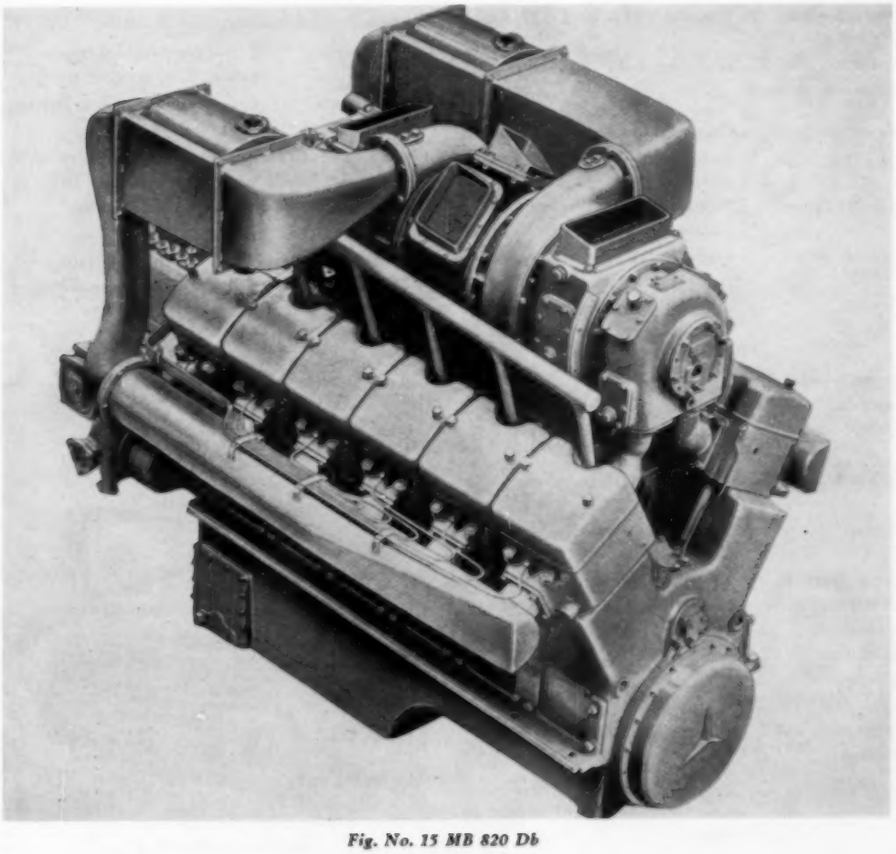


Fig. No. 15 MB 820 Db

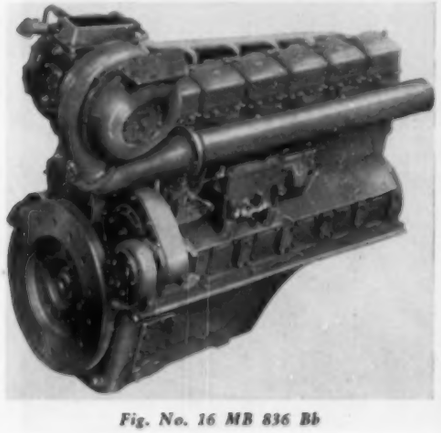


Fig. No. 16 MB 836 Bb

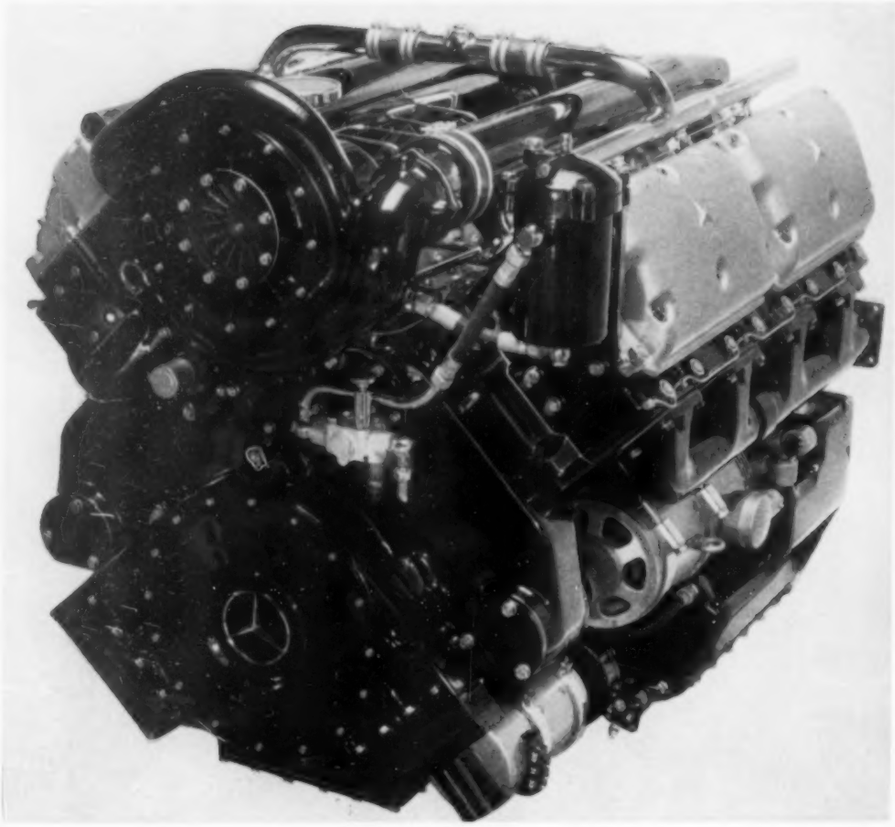
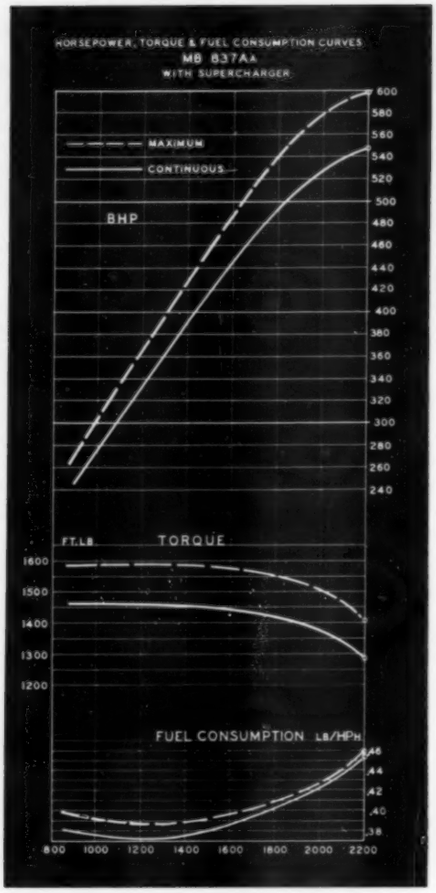
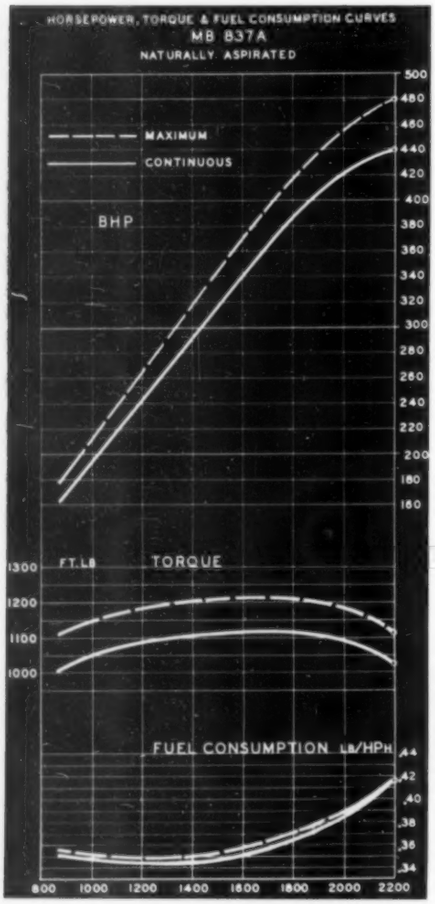


Fig. No. 17 MB 837 Aa





Characteristics Of The MB 837A and 837 Aa

8-cylinders in V, available with mechanically driven supercharger.

Engine block:	Crankcase and block an integral casting of special light metal alloy.
Cylinder liners:	Wet liners, special centrifugal casting, exchangeable.
Cylinder heads:	Light metal alloy casting for two cylinders each.
Valves:	2 intake, 2 exhaust valves per cylinder, special valve seat inserts, replaceable.
Pre-combustion chamber:	Exchangeable.
Burner:	Multi-opening, cup-shaped burner.
Rocker arms:	Activated via tappets and push rods.
Pistons:	Special light metal alloy 3 compression-, 2 oil rings.
Piston pins:	Floating, chromium steel.
Connecting rods:	Forged steel.
Crankshaft:	Forged special steel.
Crankshaft bearings:	Main: steel backed half-shell lead bronze bearings, 4 friction, 1 thrust.
Connecting rod bearings:	Steel backed half-shell lead bronze bearings.
Camshaft:	Special steel, supported in 5 removable bushing type bearings.
Oil pan:	Light metal casting.
Oil pumps:	3 gear pumps, 1 pressure pump, 2 scavenging pumps.
Water pump:	Centrifugal type, gear driven.

These engines are especially constructed to serve as power for heavy buses or trucks, fast boats or yachts and generator sets.

The engine is very light for the HP rating, (5 lbs/HP) at the same time very compact and rugged (11.5) HP per cu ft of space).
837 A natural aspirated
837 Aa supercharged.

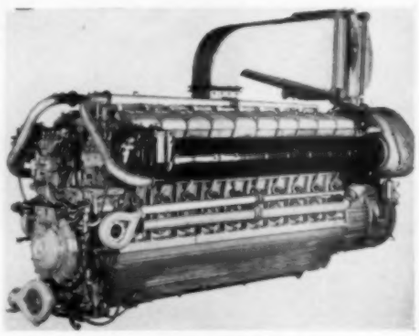


Fig. No. 18 MB 518 A

MODEL	Use	Cycle	No.Cyl.	HP	RPM	Bore	Stroke	Fuel System	Start	Supercharge	Length inch	Width inch	Height inch	Weight lbs
MB 841 B	S	4	1 h	15 21 25	600 800 1000	5.875	7.500	Robert Bosch	hand	-	46.750	33.750	37.000	1322
M 202 B	MRS	4	2 v	28 38 50 55	550 750 1000 1200	5.500	8.250	Robert Bosch	hand, E,CAP	-	36.250	30.813	45.031	1590
M 203 B	MRS	4	3 v	40 55 75 90	550 750 1000 1200	5.500	8.250	Robert Bosch	E,CAP	-	47.438	30.813	45.750	2160
M 204 B	MRS	4	4 v	55 75 100 120	550 750 1000 1200	5.500	8.250	Robert Bosch	E,CAP	-	57.188	30.813	47.313	2715
OM 636	AMRS	4	4 v	19 23 25 34	1500 1800 2000 3000	2.938	3.938	Robert Bosch	E	-	28.563	20.500	29.750	400
OM 312	AMS	4	6 v	50 60 75	1500 1800 2400	3.563	4.750	Robert Bosch	E	-	36.500	25.563	41.250	808
OM 312 A	MRS	4	6 v	65 75 90	1500 1800 2400	3.563	4.750	Robert Bosch	E	TC	36.500	28.125	43.500	837
OM 321	AMS	4	6 v	60 72 84 94	1500 1800 2200 2600	3.750	4.750	Robert Bosch	E	-	36.500	28.125	43.500	839
OM 315	AMS	4	6 v	85 105 120	1200 1500 1800	4.438	5.500	Robert Bosch	E	-	54.000	28.000	49.375	1775
OM 315 A	MRS	4	6 v	110 130 150	1200 1500 1800	4.438	5.500	Robert Bosch	E	TC	54.000	28.000	49.750	1800
OM 326	AMS	4	6 v	* 200	2200	5.031	5.500	Robert Bosch	E	-	54.000	28.000	47.375	1800
MB 846 A MB 846 B	MRS R	4 4	6 v 6 h	123 163 192 * 225	750 1000 1200 1500	5.875	7.500	Robert Bosch	E,CAP	-	73.813 74.813	31.625 48.625	60.250 28.938	4075
MB 846 Ab MB 846 Bb	MRS R	4 4	6 v 6 h	156 212 250 * 300	750 1000 1200 1500	5.875	7.500	Robert Bosch	E,CAP	TC	85.688 86.031	36.625 60.625	62.188 28.938	4298 4408
MB 846 Db	MRS	4	6 v	160 225 285 * 350	750 1000 1200 1500	5.875	7.500	Robert Bosch	E,CAP	HTC	84.000	34.031	61.813	4266
MB 836 B	MRS	4	6 v	255 300 335 * 350	1000 1200 1400 1500	6.875	8.063	Robert Bosch	E,CAM	-	76.250	41.313	59.250	3560
MB 836 Bb	MRS	4	6 v	345 415 475 * 500	1000 1200 1400 1500	6.875	8.063	Robert Bosch	E,CAM	TC	83.500	41.563	64.188	4080
MB 836 Db	MRS	4	6 v	420 520 610 * 650	1000 1200 1400 1500	6.875	8.063	Robert Bosch	E,CAM	HTC	89.563	41.313	64.188	4290
MB 820 B	MRS	4	12 Vv	510 600 675 * 700	1000 1200 1400 1500	6.875	8.063	Robert Bosch	E,CAM	-	96.125	52.750	60.625	5510
MB 820 Bb	MRS	4	12 Vv	690 830 950 *1000	1000 1200 1400 1500	6.875	8.063	Robert Bosch	E,CAM	TC	94.500	52.750	76.750	6116
MB 820 Db	MRS	4	12 Vv	840 1050 1250 *1350	1000 1200 1400 1500	6.875	8.063	Robert Bosch	E,CAM	HTC	94.500	53.563	72.813	6612
MB 837 A	AMS	4	8 Vv	200 300 390 440	1000 1400 1800 2200	6.500	6.891	Robert Bosch	E,	-	49.000	41.344	41.750	2975
MB 837 Aa	AMS	4	8 Vv	280 390 500 550	1000 1400 1800 2200	6.500	6.891	Robert Bosch	E	SC	50.000	41.344	43.750	3083
MB 518 A	M	4	20 Vv	2275 *3000	1500 1720	7.313	9.813	Robert Bosch	CAP	SC	157.500	62.250	88.750	10475

All dimensions given apply to marine and stationary engine models.
Remarks: h horizontal; v vertical; V in V; TC Turbo charger; HTC High turbo charger; SC Super charger.
E electric; CAP compressed air on piston; CAM compressed air motor.
A Automotive; M Marine; R Rail; S Stationary.
* is maximum output

PAXMAN

DAVEY, Paxman & Co. Ltd. of Colchester, England manufacture and market a wide range of modern diesel engines for rail traction and oilfield applications. The essential advantages of the Paxman range of engines are: High power with low weight and minimum overall dimensions; maximum service life with complete reliability; maximum interchangeability of wearing parts, resulting in the holding of minimum stocks of spares.

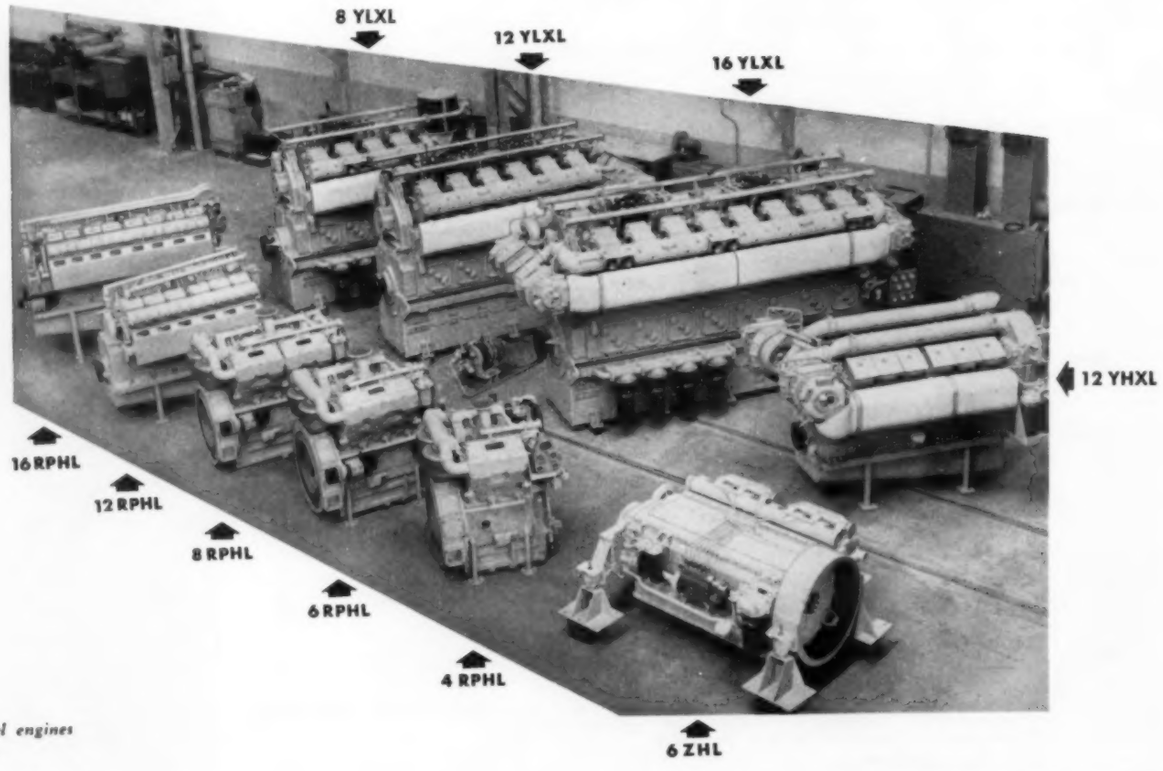
A particularly attractive constructional feature is the self-contained nature of complete assemblies. Engines for rail traction and oil well drilling duties are described in these pages, and similar details for industrial and marine applications are available on request to our Associate Company, Ruston & Hornsby Ltd. of Lincoln, England, through whom Paxman engines for these uses are distributed.

RAIL TRACTION

Paxman engines designed for rail traction use are suitable for passenger, railcar, freight or shunting locomotives. To cover a horsepower range of 133 b.h.p. to 2,000 b.h.p. only two cylinder bore sizes are used, these being 7" (seven inch) diameter for Class RPHL, Class YHXL, YHAXL, Class ZHL and ZHXL engines, and 9¾" (nine and three-quarter inch) diameter for Class YLL and YLXL engines. Classes RPH, YHX, YHAXL, ZHL and ZHXL engines have the following common items of dimensions, capacity and rotation:

Bore—7 inch
Stroke—7¾ inch
Swept volume per cylinder—298 cu. in.
Direction of rotation—Clockwise, looking on free end of engine.

4 RPH engine—¼ cutaway view

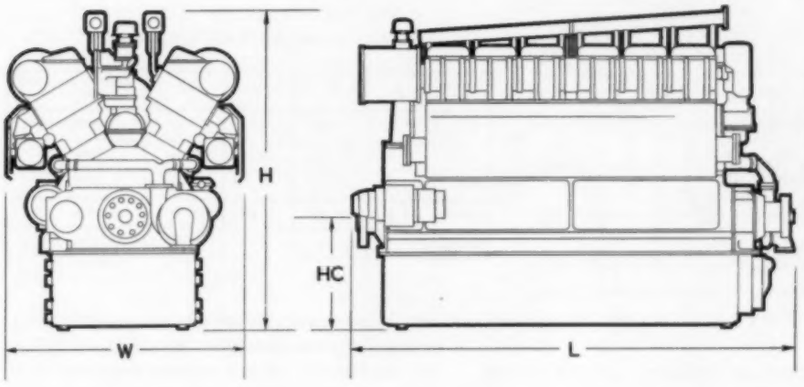


Paxman range of diesel engines 133 to 2000 b.h.p.

CLASS RPHL ENGINES

Dealing first with the 7 inch bore range, the RPHL engines are all normally aspirated and cover the horsepower range with associated technical data as shown in the following table:

Engine Type	No. of Cylinders	Traction Rating (BHP) at			BMEP (psi) at			Mean Piston Speed (ft/min) at 1500 RPM.	Fuel Consumption (lb/BHP/hr.)								
									Full load			¾ load			½ load		
		1000 rpm	1250 rpm	1500 rpm	1000 rpm	1250 rpm	1500 rpm		1000 rpm	1250 rpm	1500 rpm	1000 rpm	1250 rpm	1500 rpm	1000 rpm	1250 rpm	1500 rpm
4RPHL	4	133	155	160	88.5	82.5	70.9	1937	.413	.423	.437	.413	.436	.451	.465	.485	.536
6RPHL	6	200	250	274	88.5	88.5	81	1937	.404	.418	.427	.406	.418	.432	.453	.468	.494
8RPHL	8	267	333	366	88.5	88.5	81	1937	.396	.408	.418	.396	.408	.427	.433	.442	.485
12RPHL	12	400	500	562	88.5	88.5	83	1937	.395	.400	.413	.395	.400	.422	.420	.429	.475
16RPHL	16	533	667	750	88.5	88.5	83	1937	.395	.400	.413	.395	.400	.422	.420	.429	.475



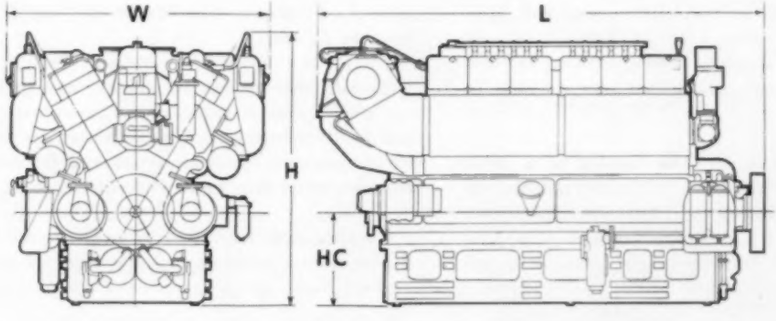
DIMENSIONS AND WEIGHTS.

Engine Type	H	L	W	HC	Approx. Dry (Nett) Weight (lb)
4RPHL	4' 6"	4' 0"	3' 6½"	1' 7½"	4500
6RPHL	4' 6"	4' 9½"	3' 6½"	1' 7½"	5600
8RPHL	4' 6"	5' 9"	3' 6½"	1' 7½"	6700
12RPHL	5' 2"	7' 6"	4' 5"	1' 9½"	10200
16RPHL	5' 2"	9' 5"	4' 5"	1' 9½"	12060

CLASS YHXL ENGINES

Class YHXL engines are all pressure-charged and cover a horsepower range with associated technical data as shown in the following table. When weight is of particular importance construction of these engines can, to a large extent, be in light alloy materials.

Engine Type	No. of Cylinders	Traction Rating (BHP) at		BMEP (psi) at		Mean Piston Speed (ft/min) at 1250 RPM.	Fuel Consumption (lb/BHP/hr.)					
							Full load		¾ load		½ load	
		1000 rpm	1250 rpm	1000 rpm	1250 rpm		1000 rpm	1250 rpm	1000 rpm	1250 rpm	1000 rpm	1250 rpm
6YHXL 6YHAXL	6	315	365	139	128.5	1615	.385	.394	.385	.394	.399	.409
12YHXL 12YHAXL	12	650	750	143.5	132.5	1615	.371	.38	.371	.38	.39	.399
16YHXL	16	865	1000	143.5	132.5	1615	.371	.38	.371	.38	.39	.399



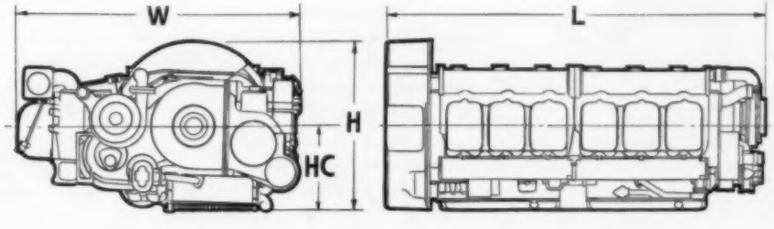
DIMENSIONS AND WEIGHTS.

Engine Type	H	L	W	HC	Approx. Dry (Nett) Weight (lb).
6YHXL	5' 2"	5' 4"	5' 2"	1' 9½"	8150
6YHAXL	5' 2"	5' 4"	5' 2"	1' 9½"	5400
12YHXL	5' 3"	8' 6"	5' 2"	1' 9½"	10950
12YHAXL	5' 3"	8' 6"	5' 2"	1' 9½"	8400
16YHXL	5' 3"	11' 0"	5' 3"	1' 9½"	13740

CLASSES ZHL AND ZHXL ENGINES FOR RAILCARS

Classes ZHL and ZHXL engines have been built specifically for railcar use and will fit conveniently beneath the car floor of vehicles built to the standard gauge. Normally aspirated engines with powers up to 300 b.h.p. comprise the ZHL range, whilst pressure-charged engines with powers up to 450 b.h.p. comprise the ZHXL range. The technical data relating to the ranges is as follows:—

Engine Type	No. of Cylinders	Railcar Rating at 1500 RPM	BMEP (psi)
4ZHL	4	200	88.5
4ZHXL	4	285	126
6ZHL	6	300	88.5
6ZHXL	6	450	132.5



DIMENSIONS AND WEIGHTS.

Engine Type	H	L	W	HC	Approx. Dry (Nett) Weight (lb).
4ZHL	3' 0"	5' 2"	5' 2"	1' 6"	3750
4ZHXL	3' 0"	6' 6"	5' 4"	1' 6"	4120
6ZHL	3' 0"	6' 11"	5' 2"	1' 6"	5570
6ZHXL	3' 0"	8' 3"	5' 4"	1' 6"	5870

CLASSES YLL AND YLXL ENGINES

The class YLL and YLXL engines meet rail traction requirements for robust medium-speed units capable of direct coupling to a single bearing traction type generator. The YLL and YLXL range of engines is equally suitable for electric, mechanical and hydraulic transmission and has a capacity for long continuous service under heavy load conditions, thus maintaining the Paxman tradition for reliability.

Developed on the 45° vee-cylinder arrangement, the YLL and YLXL series engines are available in 8-, 12- and 16-cylinder sizes. The short stroke enables a rotational speed of up to 1,000 rpm to be run with reasonable piston speed. This feature secures a high power/weight ratio and permits generator diameter and weight to be kept low.

Principal items of technical data for the YLL and YLXL engines are as follows:

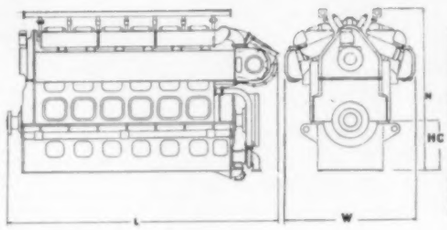
Bore–9¾ inch

Stroke–10½ inch

Swept volume per cylinder–784 cu. in.

Direction of rotation–Clockwise looking on free end of engine.

Engine Type	No. of Cylinders	Traction Rating (BHP) at 750 rpm	Traction Rating (BHP) at 1000 rpm	BMEP (psi) at 750 rpm	BMEP (psi) at 1000 rpm	Mean Piston Speed (ft/min) at 1000 RPM	Fuel Consumption (lb/BHP/hr.) Full load 750 rpm	Full load 1000 rpm	¾ load 750 rpm	¾ load 1000 rpm	½ load 750 rpm	½ load 1000 rpm
8YLL	8	563	710	95	90	1750	.37	.39	.37	.39	.4	.43
8YLXL	8	750	1000	126	126	1750	.361	.39	.361	.38	.375	.4
12YLL	12	844	1070	95	90	1750	.37	.39	.37	.39	.4	.43
12YLXL	12	1125	1500	126	126	1750	.361	.39	.361	.38	.375	.4
16YLXL	16	1500	2000	126	126	1750	.361	.39	.361	.38	.375	.4



DIMENSIONS AND WEIGHTS

Engine Type	H	L	W	HC	Approx. Dry (Nett) Weight (lb).
8YLL	7' 5¼"	9' 3⅜"	5' 10"	2' 3½"	19200
8YLXL	7' 5¼"	9' 6⅜"	6' 2"	2' 3½"	21050
12YLL	7' 5¼"	11' 6⅜"	5' 10"	2' 3½"	26150
12YLXL	7' 5¼"	12' 3⅜"	6' 0"	2' 3½"	27500
16YLXL	7' 5¼"	15' 5"	6' 2"	2' 3½"	36700

TRANSMISSIONS

Paxman engines are eminently suitable for all types of rail traction transmissions on locomotives, diesel trains and rail cars. When installed as a diesel electric unit with single bearing generator a four point system of resilient mountings will suffice. For mechanical and hydraulic transmissions three or four point resilient mountings can be arranged direct to the locomotive main frames.

OILFIELD POWER UNITS (DRILPAKS)

For Oilwell Drilling and Pumping Duties. The Paxman Oilfield Package Set (Drilpak) is available in seven sizes and covers outputs from 100 to 800 continuous shaft horsepower. The standard set incorporates hydraulic coupling transmission but torque converter transmission is also available. For higher outputs, particularly for pumping duties, these sets can easily be compounded.

Years of oilfield experience in all parts of the world are embodied in the design of the Paxman DRILPAK Package Set thereby resulting in all possible aspects being covered, namely:

(a) Proven reliability on draw-works and mud pump drive throughout the world.

(b) Basic constructional simplicity resulting in the expenditure of minimum maintenance time.

(c) Interchangeabality of 70% of the component parts provides for the minimum of spares stocking.

(d) Fully self-contained power packs, easily manhandled and transportable.

(e) Full use is made of the Unified and A.P.I. screw and pipe threads respectively.

(f) Plastic dipped spares for unlimited storage duration.

(g) Continuous after sales field service by factory trained personnel.

Many hundreds of Package Sets are in service in the major oilfields of the world, and are operating under varying conditions with every satisfaction. Oilmen everywhere acclaim and respect their performance, rugged construction and dogged dependability.

It is of the utmost importance that oilfield equipment is easy to handle. The Paxman 7 inch bore engine, being robust and compact, having a light overall weight, is the ideal prime mover for incorporating in a "packaged" power unit. The Paxman DRILPAK has been designed to meet the demands of the oil drilling industry, and it is suitable for incorporating in existing American or British rigs.

The Paxman power unit consists of a diesel engine (in a wide range of powers) mounted on a rigid skid underbase to form the simplest connection to the drive group. Included as integral parts of the Paxman "Packaged" unit are the following main features:

1. Gear Type Coupling which makes the Paxman DRILPAK readily adaptable for use with any make of rig. When changing engine units this is the only unit disturbed, and the greatest use may thus be made of the high degree of interchangeability that exists between sets of varying horsepowers.

2. Scoop Control Fluid Drive Coupling, or alternatively a Torque Converter, isolating the engine from any shock loads from the drive group. The Scoop in the coupling permits ready re-engagement of any engine and can be remotely controlled from the rig floor.

3. Busbar, which groups all external services at one central position and facilitates easy servicing and rapid connection and disconnection for exchange purposes. All pipes are coloured for easy reference and utilize A.P.I. connections.

4. Radiator, with fan driven by anti-static A.P.I. Belting, for cooling the circulating water for the engine cylinder jackets and lubricating oil coolers.

5. Engine Lubricating Oil Coolers are fitted in series with the engine cooling water circuit.

6. Tubular Cooler, fed from independent water supply for cooling fluid coupling oil and self-contained radiator cooled circuit for Torque Converter oil. This radiator is mounted above the

DRILPAK Type	Engine Type	No. of Cylinders	DRILPAKS fitted with Fluid Couplings. Shaft-horsepower output at various speeds. 900 rpm	1000 rpm	1100 rpm	1200 rpm	DRILPAKS fitted with Brockhouse Torque Converters. Maximum Horse-power input to torque converter	Maximum Governed Speed(rpm)	Maximum Torque (lb.ft.)	Full Load Engine Speed Range (rpm)
100	6RPHW	6	100	110	120	128	137	1250	1650	1060 - 1250
200	6RPHW	6	190	186	183	200	227	1300	2840	1100 - 1300
300	8RPHW	8	200	222	243	265	307	1370	3440	1220 - 1370
400	12RPHW	12	300	333	367	400	427	1250	5340	970 - 1250
500	16RPHW	16	400	444	490	533	573	1250	7400	955 - 1250
700	12YHXM	12	450	500	550	600	640	1250	8260	1015 - 1250
800	16YHXM	16	600	667	733	800	876	1315	10500	1170 - 1315

Gas Engines - When a supply of sweet, dry natural gas is available, the Paxman 6,12 & 16YHG spark ignition gas engine having the same bore & stroke as the equivalent RPH diesel engine can be employed for constant speed duty. The output of these engines is the same as the normally aspirated 6, 12 & 16 RPH engines. Full particulars can be obtained from the manufacturers

NOTES:

(i) The shaft horse powers quoted are the outputs continuously available at the output coupling after deducting all power absorbed by the radiator fan, water pumps, and transmission at any site.

(ii) This table applies to Drilpak Sets equipped with hydraulic couplings.

(iii) "X" denotes engines pressure-charged by means of exhaust gas driven turbo blowers.

Torque Converter and its fan is driven by anti-static A.P.I. belting from the input to the Torque Converter.

The following items can be fitted as extras to any standard set:

1. Canopy, with removable sides, for weather protection.
2. Daily service tank.
3. Automatic cut-out gear for engine shut down in the event of lubricating oil or cooling water pressure failure.

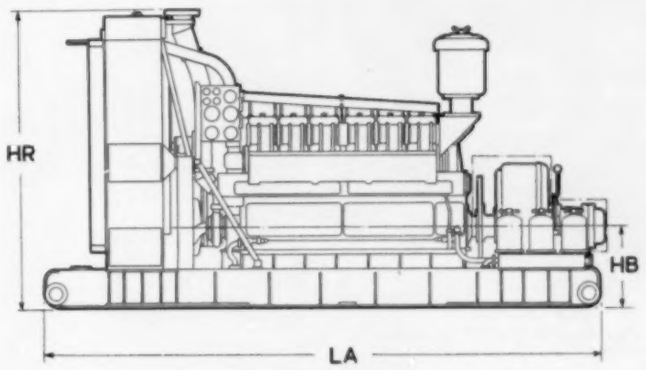
The RPHL and YHXL engines, as already described, are the prime movers and the principal data for complete packaged sets are as given at right:

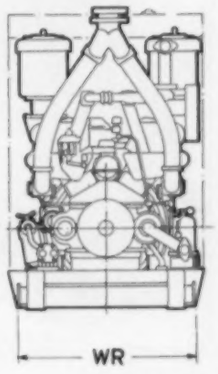
SPECIFICATION	RPH	YHX
S.M.E.P. lb/sq. in.	76.5	117
Compression ratio	17.25:1	14.25:1
Injection Pressure lb/sq. in.	1800	3000
Mean Piston Speed at 1200 r.p.m. in ft/min	1550	1550
Rotation looking on radiator end	Clockwise	Clockwise

TABLE OF FUEL AND LUBRICATING OIL CONSUMPTIONS BASED ON 1200 R.P.M. ENGINE SPEEDS

DRILPAK Type	Engine Type	Fuel Consumption (lb/SHP/hr.) at 1200 RPM. Full load	¾ load	½ load	Oil Consumption (U.S.Gals./eng.hr.
100	4RPHW	.433	.462	.53	.15
200	6RPHW	.435	.464	.54	.225
300	8RPHW	.434	.446	.51	.300
400	12RPHW	.43	.443	.5	.345
500	16RPHW	.43	.444	.48	.435
700	12YHXW	.4	.413	.453	.345
800	16YHXW	.4	.412	.45	.435

NOTE: All fuel consumption figures given are for engines tested at our Works on fuel to BS.209 (1947) Class A, which is a fuel with a cetane value of 45 and a net calorific value of not less than 18,300 B.T.U.s/lb.





TABLES OF WEIGHTS, DIMENSIONS AND SHIPPING SPECIFICATIONS OF COMPLETE DRILPAK SETS.

Drilpak Type	Engine Type	Dimensions LA	HB	HR	WR	Weights Excluding Water and Oil Net.Wt. Unpacked (lb)	Gross Wt. for Export short(tons)	Shipping Specifications. Case Dimensions Length Ft. In.	Width Ft. In.	Height Ft. In.	Volume (cu. ft)
100	4RPHW	8'3"	2'1"	6'9"	4'8"	9,300	5.26	9. 0.	5. 6	7. 9	384
200	6RPHW	9'9"	2'1"	7'2"	4'8"	12,800	6.95	10. 6	5. 6	8. 3	477
300	8RPHW	11'6"	2'1"	7'8"	5'1"	15,000	8.00	12. 3	5. 10	8. 9	626
400	12RPHW	14'10"	2'1"	7'9"	5'1"	18,690	10.4	14. 9	5. 10	8. 9	752.5
500	16RPHW	16'8"	2'1"	7'9"	5'9"	21,900	12.3	17. 6	6. 6	8. 9	995
700	12YHXW	15'2"	2'1"	7'9"	5'1"	19,800	11.0	15. 9	5. 10	8. 9	804
800	16YHXW	17'4"	2'1"	7'9"	5'9"	23,350	12.7	17. 9	6. 6.	8. 9	1010

SPARES

It is fully recognized that spare parts should arrive on site suitably labelled for identification and preserved to withstand long storage in moist atmospheres. Paxman spares are fully preserved in a plastic coating, and both the part and the container are clearly labelled with the part number and clients' order number.

We have an independent manufacturing and stores organization for spare parts, which are produced to a predetermined manufacturing schedule, to ensure that adequate stocks are maintained in the stores to meet our customers' requirements. We are also able to dispatch within 24 hours any part required for an emergency.

PACKING AND TROPICALIZATION

Packing is carried out in three different forms:

1. For United Kingdom use where prolonged storage is not required;
2. For Continental use and air freight transport;
3. For orders exported to tropical countries where parts are to be in transit or stored for long periods. Here full preservation methods and specially designed containers are used.

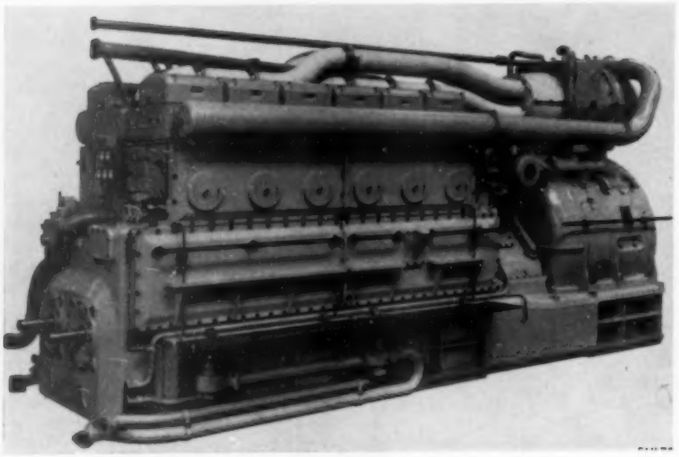
INTERCHANGEABILITY

Engineers in all branches of industry will be quick to appreciate the large saving in spares storage space and maintenance expenditure effected by the use of a standard prime mover for all their power applications. We have endeavored to ensure the continuance of the same design features throughout the various ranges of Paxman engines in any of the applied fields in which they work, i.e. oil fields, rail traction, marine propulsion and auxiliary, or for industrial generation. Where various engines of one range are operating on one base or locality, the stock of spare parts may, therefore, be kept to a minimum.

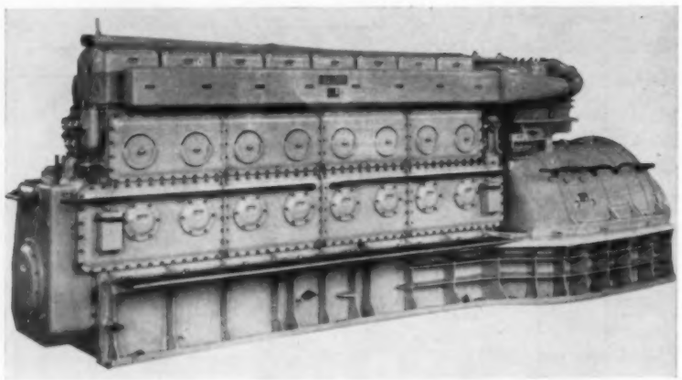
Consequently, 70% of the wearing parts of our 7 inch bore diesel engines are completely interchangeable; therefore, any user of several sized Paxman's Diesels need hold only a basic set of spares covering these components.

Paxman oilfield Drilpak 400 showing unit assembly.

SULZER BROS.



12 cyl. LDA28 Engine, 2300 BHP at 750 rpm as used by British Railways and French National Railways.



1200 hp at 750 rpm Sulzer Traction Engine.

SULZER TWO-CYCLE TRUNK PISTON STANDARD TYPES

Basic Type*	No. Of Cylinders	Bore	Stroke	BHP Continuous, Per Cylinder	RPM
T24	4 and 6	240	400	75	400
T29	4 to 9	290	500	120	360
T36	4 to 10	360	600	180	300
T48	4 to 12	480	700	350	250
T56	5 to 8	560	1000	400	155

*Various differences between stationary and marine types.

SULZER TWO-CYCLE CROSSHEAD STANDARD TYPES

SD60	4 to 12	600	1040	500	150
SAD60	4 to 12	600	1040	640	150
SD72	4 to 12	720	1250	700	125
SAD72	4 to 12	720	1250	900	125
RSD58	4 to 12	580	760	520	240
RSD76	4 to 12	760	1550	1000	119
A: RSAD76	4 to 12	760	1550	1300	119
**					

A: exhaust turbocharged **largest type not yet listed

SULZER FOUR-CYCLE STATIONARY & MARINE AUXILIARY ENGINES

BA22	3 to 8	220	320	75	600
BA29	5 to 8	290	360	185	500
BAF36	8	360	440	250	400

SULZER FOUR CYCLE LOCOMOTIVE ENGINES

6LDA19	6	190	420 (total)	1100
6LDA22	6	220	570 (total)	950
6LDA25	6	250	735 (total)	850
8LDA25	8	250	960 (total)	850
6LDA28	6	280	920 (total)	750
8LDA28	8	280	1200 (total)	750
12LDA28	12	280	2350 (total)	750

SULZER TWO-CYCLE ENGINES are of heavy-duty type with low piston speeds. They are of trunk piston-design for the smaller sizes with the prefix "T", of crosshead-type for the larger sizes with prefix "S". All have loop scavenging and are thus well suited for operation on residual fuels. Scavenging air is provided by reciprocating pumps, one for each cylinder, attached to one side of the cylinder bank. "T" engines have cast-iron frames and bedplates. S engines can be specified with either cast-iron or welded frames and bedplates. "T" engines have cylinders and crankcases consisting of one or two blocks, depending on the number of cylinders. S engines have individual cylinders bolted together and crankcases built up of individual A frames bolted together so as to form a rigid box which is machined in one piece. Cylinder liners are of close-grained cast-iron and are fitted, at the top, with a fire ring for improved combustion. Crankshafts are of acid open-hearth steel, consisting of one or two pieces, depending on number of cylinders. Fuel pumps and injectors are of Sulzer design. Pistons are oil-cooled. They are of symmetric design, with flat tops, to prevent cracking. Camshafts are gear-driven for all engine types except the largest; for the latter, chain drive is used in order to bring the fuel pumps close to the injectors without excessive gearing.

All marine engines are direct-reversible. The smaller types can also be had with reversing gears. For the smaller marine engines, engine-driven cooling water and bilge pumps can be provided. All larger types can be supplied with exhaust gas turbochargers, providing a power increase of 30% or more. The larger types have turbo-charging as standard equipment.

SULZER 4-CYCLE ENGINES are built for stationary use, as auxiliaries on board ships and for locomotive use. They have conservative piston speeds, for heavy-duty service.

Stationary engines and those used as auxiliaries on ships are of the same basic type with prefix "B". The smaller engines have from 3 to 8 cylinders, the larger ones from 6 to 8 cylinders. Locomotive engines are of different types and of higher speeds. Bedplates, of cast-iron, are in one piece. Frame and engine block, of cast-iron, also are of one piece. Cylinder liners are of close grained cast-iron. Crankshafts are of acid open-hearth carbon steel. The cylinders have individual heads, with one inlet and one exhaust valve. Crankshafts are gear-driven. Individual Sulzer fuel injection pumps are provided for each cylinder.

LOCOMOTIVE ENGINES—These are built in four cylinder sizes. They range from 350 hp to 2,300 hp. The smaller bore engines are built with 6 or 8 cylinders, the larger ones 8 or 12. The 12-cylinder engines consist of two vertical banks of 6 cylinders, mounted on a single crankcase, driving two crankshafts connected through gears which actuate a driving shaft at higher speed. Where indicated, crankshafts are fitted with dynamic vibration dampers. Bedplate, crankcase and block are of welded construction, providing exceptional rigidity and light weight. Pistons are of aluminum alloy, connecting rods of chrome nickel steel, fully machined. All traction engines are turbocharged. A pressure changing safety device limits full delivery in function of the momentary volume of charging air.

AIR COOLED DIESEL ENGINES STATIONARY, COMBINED UNITS, MARINE, AUTOMOTIVE

DEUTZ

DEUTZ builds a full range of engines of the four and two cycle type. Most of these are oil engines, but several special models have been developed for operation on natural or city gas.

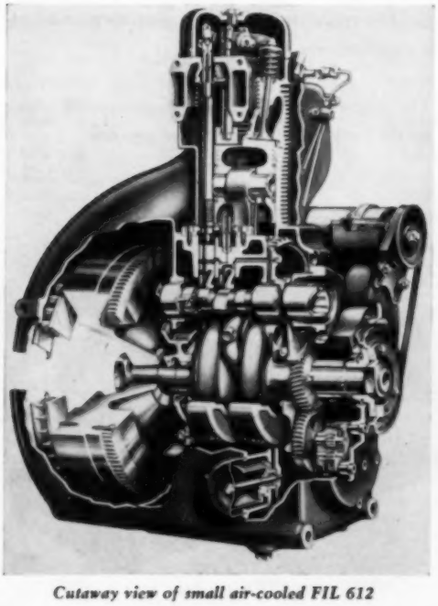
The 1955 range of Deutz engines consists of 62 models ranging from 6 to 2000 B.H.P. Of these, 29 models are of the high speed type turning between 1000 and 2300 RPM, while 25 models turn between 500 and 1000 RPM and 8 models turn below 600 RPM.

Deutz Two Cycle

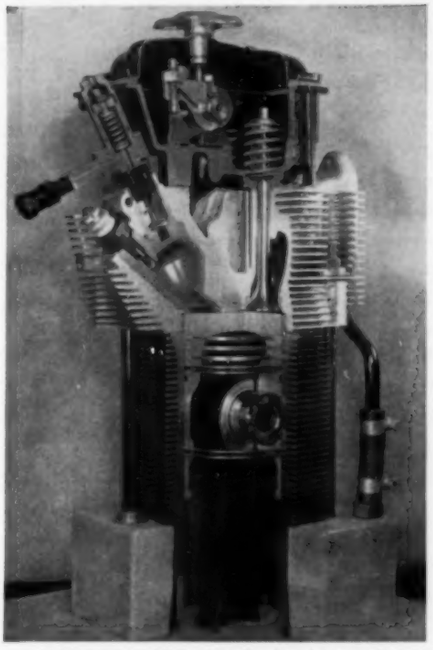
The Model TM series are valveless two-cycle, water-cooled engines designated as 2, 3, 4, 8, and 12 cylinder units incorporating the loop scavenging system designed by the late Dr. Schnuerle. This system provides for air blower scavenging of the cylinders and feeds them with fresh air for combustion through intake ports in the liners when the pistons reach the end of the power stroke. Complete exhaust gas discharge through the exhaust ports with subsequent intensive scavenging and filling of the cylinder with clean air is made possible by the special design and arrangement of the intake ports.

Available as stationary, portable, oil field or marine propulsion units, the TM Models have a horsepower range between 47 and 750 BHP and turn between 500 and 1000 RPM.

The larger marine engines are of the direct-reversing type but can be furnished with reversing and reduction gears. The TM engines are low in weight and compact in size.



Cutaway view of small air-cooled FIL 612



Cutaway view of cylinder head and piston of Model F/AL514/614

Deutz Four Cycle Engines

All other DEUTZ engines are of the four cycle type. Special engines are available for stationary, automotive, portable oil field and marine application. The larger engines can be equipped with turbo-superchargers of the "BUCHI" type, which permit increased output over non-supercharged engines by as much as 60%, without adversely affecting engine life or reliability. Of special importance for marine propulsion is the fact that many of the heavier models are directly reversible. All models are available with reversing and reduction gears.

DEUTZ also manufacturers complete generator, compressor and pump units for all applications. These units are available skid or trailer mounted.

Deutz Air Cooled Diesels

The crowning achievement of the DEUTZ line rests in the development of efficient AIR COOLED ENGINES.

The advantages of air-cooling on Diesels are numerous.

Direct air-cooling eliminates the breakdown causes inherent in water-cooling such as leaks, scale deposits, freezing and overheating. Air cooled engines warm up faster, a factor of particular importance on short runs.

Faster warm up starting facilitates, reduces fuel and lube oil consumption especially on partial loads and cuts cylinder wear down to a minimum.

Faster starting due to the fact that combustionable air is subject to a higher compression temperature because of the special design of Deutz cylinder heads and turbulence chambers is another important factor. Hot combustion chambers with low charge result in lowered fuel consumption. Deutz reaches a new low here with fuel consumption at 0.406 lbs BHP hr.

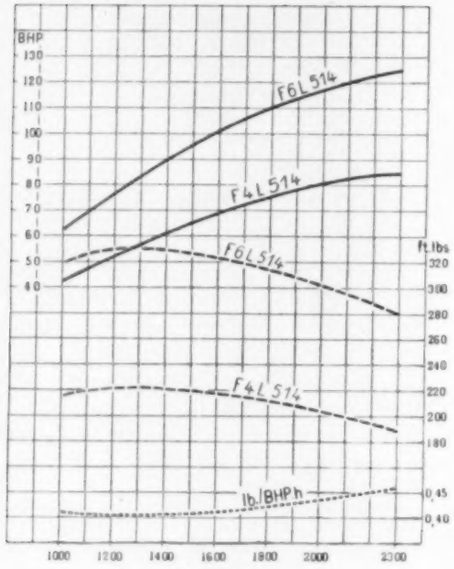
The higher cylinder wall temperature of DEUTZ diesels offers considerable advantages especially on heavy loads, avoiding oxidation of sulphur from sulphur-containing fuels that condense in the form of sulphurous acid. DEUTZ Diesel construction prevents lubricating oil decomposition and the wearing out of cylinder liners.

Design of Deutz Air Cooled Engines

CRANK CASE: Cast iron, heavily ribbed extends well beyond crank shaft center for greater rigidity. The oil pan is made of cast iron, sheet metal or light metal depending on engine use.

CRANK SHAFT: With the exception of the single cylinder units, where crank and camshaft run on roller bearings, all crank shafts run on lead-bronze bearings supported at each journal. In the V-type engine with cylinders at 90 degrees two opposed

Deutz air-cooled 12 cylinder A/FL 614



pistons act on a common journal with connecting rods operating side by side.

CAM SHAFT: Cam shafts on in-line types are of the usual design. The V-type engines have a single cam shaft placed above the crankshaft.

PISTONS: The light metal pistons carry three compression rings and two slotted oil rings of the usual design. Due to the efficiency of the air-cooling neither ring expanders nor any kind of special rings are required. To obtain almost soundless operation, the gudgeon pin is placed off piston center.

CYLINDERS: Special cast cylinders are ribbed over almost the entire stroke length. They are sealed from the crank case by means of a rubber gasket and against the cylinder head by means of a special gasket. Cylinders together with the cylinder head are secured to the crank case by means of four bolts. Vanes provide uniform heat dissipation over the entire cylinder head.

CYLINDER HEAD AND VALVE GEAR: The light metal cast cylinder head is heavily ribbed and contains the combustion and turbulence chambers and valve ports. The valve mechanism is located in an oil-tight mounting closed with a detachable cover. Valve clearance is kept uniform through the use of special light metal alloy push rods.

COOLING AIR BLOWER: Blower is located in front of engine. It is of the axial flow type with rotor, bearings and driving elements secured by a screw. V-Belts drive blower on in-line engines, and a gear drive for V-types Blower capacity is 1765 2120 cu. ft./BHP hr. Efficiency is above 80%. Consequently power consumption will never exceed requirements of fan and water pump of a water-cooled engine.

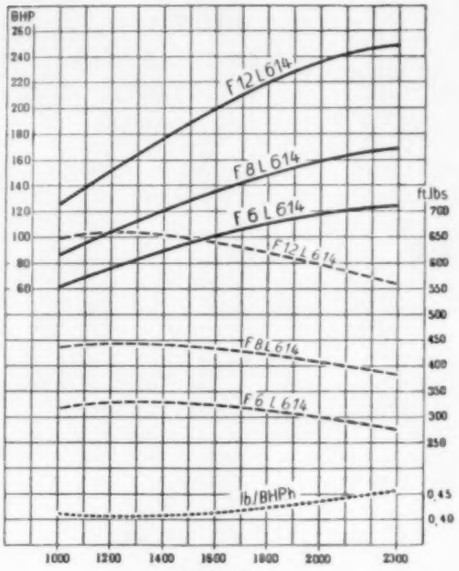
Proper belt tension is maintained through a spring-loaded tightener pulley equipped with recoil protection device. Belt can be tightened further through generator rocker mounting arrangement. Warning signal notifies operator of blower drive failure.

COOLING AND CIRCULATION: Blower impelled air is collected in a chamber and flows around the cylinders and cylinder heads towards the exhaust side of the engine. In V-type engines cooling air is distributed equally across both cylinder rows.

INJECTION PUMP AND GOVERNOR: Single, 2 and 3 cylinder engines are equipped with a DEUTZ manufactured Helix plunger type injection pump. This is combined with a centrifugal mechanical governor adjustable by means of spring tension.

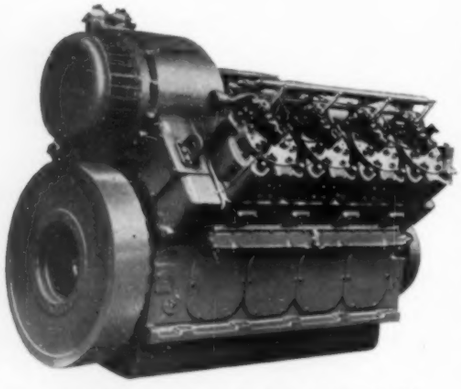
Four to twelve cylinder engines are equipped with Bosch injection pumps. Automotive engines are provided with governors having nominal idling and maximum speed controls. Stationary engines have governors, with automatic speed controls over the full range. All engines are equipped with Bosch nozzle holders and Bosch pintle type nozzles.

LUBRICATION AND OIL COOLER: High pressure oil pump circulates lube oil to all moving parts. Rocker arms on top of the cylinder head are oil fed from the camshaft bearings through the tappets and the hollow push rods. A special oil cooler with provisions for air circulation is used in the larger engines and is intended for use in the tropics. Heat reduction through the oil cooler is about 10% of the total heat removed. The oil cooler is by-passed by means of a spring charged valve as long as the oil is cold.

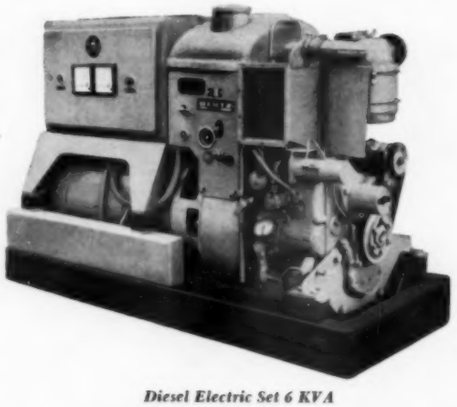


FUELS: In addition to the advantages of air-cooling, DEUTZ Diesel engines can be run on gasoline as direct-injection engines with minor adjustments. Kerosene and similar fuels can replace diesel fuel oil without any special adjustment. It is obvious that the use of gasoline in Diesel engines may be very important in certain cases. For instance, if the engine has to run at such low temperatures that the fuel oil jells, or on occasions when it is not possible to fill up with fuel oil. Engines manufactured from the start for *alternate operation on DIESEL oil or gasoline,* can be switched from one fuel to the other by means of a single lever operation. For gasoline operation, automotive gasoline mixed with a slight amount of oil is used.

The following tables give all engine specifications on the Full Deutz Diesel line of engines:



Two cycle Deutz Diesel Engine T 8 M 625 433 H.P. at 650 rpm.



Diesel Electric Set 6 KVA

DEUTZ DIESEL ENGINE SPECIFICATIONS

Model	Use	Cycle	No. Cyl.	Bore Stroke	Cont. HP.	Cont. RPM.	Fuel System	Start	Super-charge	Rev. Gear	Length, In.	Width, In.	Height, In.	Weight, Lb.
MAH 711	SPM	4	1	3 15/16x4 5/16	6	1500	O	H	.....	.....	30 1/2	23 1/8	20 1/8	374
MAH 914	SPM	4	1	4 1/2x5 1/2	11	1500	O	H	.....	.....	38 1/2	29 3/8	25 1/2	693
MAH 916	SP	4	1	4 3/4x6 3/8	16	1300	O	HA	.....	.....	43 3/16	34 1/4	27 1/8	957
MAH 320	SP	4	1	6 1/4x7 7/8	26	1000	O	HA	.....	.....	54 1/2	38 3/8	31 1/4	1,694
F2M 417	SP	4	2	4 3/4x6 3/8	32	1800	O	HE1	.....	.....	54 1/2	28 1/2	43 5/16	1,441
F1L612•	SPM	4	1	3 1/2x4 3/8	10	2000	O	HE1	.....	.....	23 3/8	20 5/16	30 1/4	429
F2L612•	SPM	4	2	3 1/2x4 3/8	20	2000	O	HE1	.....	.....	30 7/16	20 1/8	30 1/4	506
F4L 612•	SPM	4	4	3 1/2x4 3/8	40	2000	B	E1	.....	.....	34 3/8	25	32 1/4	595
A1L 514•	SPM	4	1	4 3/8x5 1/2	16	1800	B	HE1	.....	.....	21 1/2	24	40 3/8	723
A2L 514•	SPM	4	2	4 3/8x5 1/2	32	1800	B	HE1	.....	.....	27	26 1/2	37 1/2	913
A3L 514•	SPM	4	3	4 3/8x5 1/2	48	1800	B	HE1	.....	.....	30	26 7/16	37 1/2	1,012
A4L 514•	SPM	4	4	4 3/8x5 1/2	60	1800	B	E1	.....	.....	42	29 1/8	41 3/8	1,210
A6L 514•	SPM	4	6	4 3/8x5 1/2	100	1800	B	E1	.....	.....	63	33	40	1,606
A6L 614•	SP	4	6V	4 3/8x5 1/2	100	1800	B	E1	.....	.....	38 3/8	45 5/8	25	1,672
A8L-614•	SPM	4	8V	4 3/8x5 1/2	130	1800	B	E1	.....	.....	42 1/8	42 1/2	35 5/8	1,936
A12L-614•	SPM	4	12V	4 3/8x5 1/2	200	1800	B	E1	.....	.....	66 5/8	47 3/4	34 1/8	2,794
F1L 514•	Automotive	4	1	4 3/8x5 1/2	16	1800	O	HE1	.....	.....	21 1/2	24	40 1/4	723
F2L 514•	Automotive	4	2	4 3/8x5 1/2	32	1800	O	HE1	.....	.....	27	26	37 1/2	913
F3L 514•	Automotive	4	3	4 3/8x5 1/2	48	1800	O	HE1	.....	.....	30	26 7/16	37 1/2	1,012
F4L 514•	Automotive	4	4	4 3/8x5 1/2	85	2300	B	E1	.....	.....	42	29 1/8	41 3/8	1,078
F6L 514•	Automotive	4	6	4 3/8x5 1/2	125	2300	B	E1	.....	.....	63	33	40	1,430
F6L 614•	Automotive	4	6V	4 3/8x5 1/2	125	2300	B	E1	.....	.....	38 3/8	45 5/8	25	1,595
F8L 614•	Automotive	4	8V	4 3/8x5 1/2	170	2300	B	E1	.....	.....	42 1/8	42 1/2	35 5/8	1,870
F12L614•	Automotive	4	2V	4 3/8x5 1/2	250	2300	B	E1	.....	.....	66 5/16	47 3/4	43 7/8	2,750
A4M 517	SPM	4	4	5 1/8x6 3/4	83	1500	B	AE1	.....	.....	53 7/8	22	47 5/8	1,980
A6M 517	SPM	4	6	5 1/8x6 3/4	128	1500	B	AE1	.....	.....	58 1/2	29 1/8	47 5/8	2,552
A8M 517	SPM	4	8	5 1/8x6 3/4	170	1500	B	AE1	.....	.....	83 1/2	29 1/8	47 5/8	2,992
BA8M 517	SPM	4	8	5 1/8x6 3/4	250	1500	B	AE1	TC	.....	83 1/2	29 1/8	50 3/4	3,300
F6M 617	Automotive	4	6	5 1/8x6 3/4	175	1800	B	E1	.....	.....	62 1/8	29 1/8	47 5/8	2,420
T4M 320	SPM	2	4V	6 7/8x7 7/8	133	800	O	AE1	.....	.....	49 1/2	51 3/4	50 3/8	3,110
T8M 320	SPM	2	8V	6 7/8x7 7/8	267	800	O	AE1	.....	.....	79 3/8	47 1/4	60 7/8	4,895
T12M 320	SPM	2	12V	6 7/8x7 7/8	400	800	O	AE1	.....	.....	98	62 3/8	63 3/8	7,040
T4M 420	SPM	2	4V	6 7/8x7 7/8	167	1000	O	E1	.....	.....	49 1/2	51 3/8	50 3/8	3,245
T8M 420	SPM	2	8V	6 7/8x7 7/8	333	1000	O	E1	.....	.....	79 3/8	47 1/4	60 7/8	4,730
T12M 420	SPM	2	12V	6 7/8x7 7/8	500	1000	O	E1	.....	.....	98	51 3/8	62 3/8	6,600
T2M 425	SPM	2	2	5 7/8x9 7/8	47	600	O	A	.....	.....	52 1/4	36 3/8	55 1/2	4,510
T3M 425	SPM	2	3	5 7/8x9 7/8	71	600	O	A	.....	.....	61	36 3/8	55 1/2	5,445
T4M 425	SPM	2	4	5 7/8x9 7/8	95	600	O	A	.....	.....	71	36 3/8	55 1/2	6,380
T4M 525	SPM	2	4V	6 7/8x9 7/8	216	650	O	A	.....	D	63 3/8	59	76 3/4	6,710
T8M 525	SPM	2	8V	6 7/8x9 7/8	433	650	O	A	.....	D	68 1/8	59	76 3/4	9,790
T12M 525	SPM	2	12V	6 7/8x9 7/8	650	650	O	A	.....	D	116 5/16	59	76 3/4	12,540
T4M 625	SPM	2	4V	6 7/8x9 7/8	250	750	O	A	.....	D	63 3/8	59	76 3/4	6,710
T8M 625	SPM	2	8V	6 7/8x9 7/8	500	750	O	A	.....	D	68 1/8	59	76 3/4	9,790
T12M 625	SPM	2	12V	6 7/8x9 7/8	750	750	O	A	.....	D	116 5/16	59	76 3/4	12,540
T4M 233	SPM	2	4	8 5/8x13	250	500	B	A	.....	D	93	57 1/2	72 1/2	10,120
T8M 233	SPM	2	8V	8 5/8x13	500	500	B	A	.....	D	110	96 7/8	70 3/4	14,520
A4M 428	SPM	4	4	8 5/8x11	150	600	O	A	.....	.....	78	35 7/8	64 1/8	7,590
A6M 428	SPM	4	6	8 5/8x11	250	600	O	A	.....	D	104 1/2	35 7/8	64 1/8	10,120
A8M 428	SPM	4	8	8 5/8x11	310	600	O	A	.....	D	115 1/4	35 7/8	64 1/8	2,650
V6M 436	SPM	4	6	9 1/2x14 1/8	300	500	O	A	.....	D	134	42	77	21,230
V6M 536	SPM	4	6	10 5/8x14 1/8	375	500	O	A	.....	D	134 5/8	42	82 1/4	21,450
V8M 536	SPM	4	8	10 5/8x14 1/8	500	500	O	A	.....	D	163 1/4	42	82 1/4	27,500
V6M 545	SM	4	6	12 5/8x17 3/4	500	375	O	A	.....	D	160 5/8	53	95	33,000
V8M 545	SM	4	8	12 5/8x17 3/4	660	375	O	A	.....	D	105 1/4	53	95	41,500
BV6M 536	SPM	4	6	10 5/8x14 1/8	560	500	O	A	TC	D	140	42	94	2,000
BV8M 536	SPM	4	8	10 5/8x14 1/8	750	500	O	A	TC	D	140	42	94	27,940
BV6M 545	SM	4	6	12 5/8x17 3/4	800	375	O	A	TC	D	165 7/8	53	128 1/4	33,880
BV8M 545	SM	4	8	12 5/8x17 3/4	1060	375	O	A	TC	D	200 5/8	53	128 1/4	43,230
V6M 366	SM	4	6	16 1/2x26	915	275	O	A	.....	D	240	71 1/8	142	93,940
V8M 366	SM	4	8	16 1/2x26	1210	275	O	A	.....	D	295	71 1/8	142	117,920
BV6M 366	SM	4	6	16 1/2x26	1500	275	O	A	TC	D	245 1/2	71 1/8	173	93,940
BV8M 366	SM	4	8	16 1/2x26	2000	275	O	A	TC	D	299 1/8	71 1/8	173	119,460

All dimensions given apply to the stationary engine models.

•These engines are air-cooled and equipped with turbulance chambers in the cylinder heads.

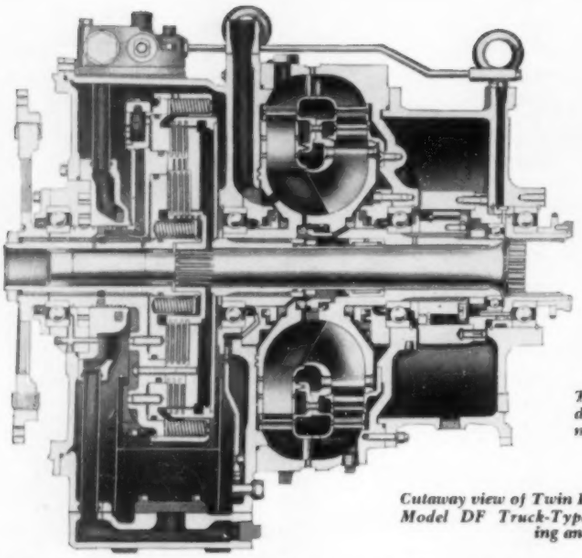
Model TM425 is equipped with scavenging air blower of the Roots type and Model 320/420 TM525/625 and TM233 with scavenging air blower of the centrifugal type.

The large marine engines are available also of the directly reversible type.

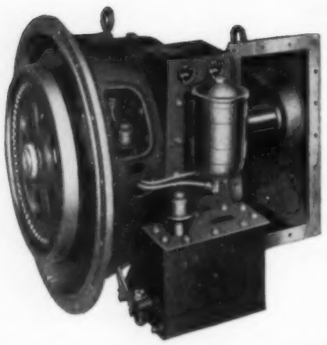
S—Stationary
P—Portable
B—Bosch
H—Hand cranking
TC—Turbo-charger
D—Direct reversing
M—Marine
O—DEUTZ Manufacture
A—Air starting
E1—Electric starting

TWIN DISC

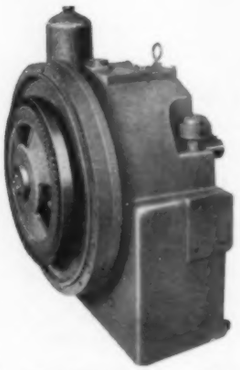
HYDRAULIC TORQUE CONVERTERS



Cutaway view of Twin Disc Three-Stage Torque Converter, Model DF Truck-Type, with built-in Converter Braking and Lock-out Drive.



Twin Disc Three-Stage Torque Converter, Model F Industrial-Type, with flange-type input for direct connection to engine flywheel; Type A output (narrow-chain housing).



Twin Disc 1500 series single-stage torque converter, is one of two models currently available. Also offered in 1300 Series.

TO meet the requirements of every type of diesel installation from 30 to 1000 horsepower, Twin Disc Clutch Company offers a complete line of torque converters. Included are both single-stage and three-stage units, in a wide range of types, sizes and capacities, with a broad variety of input and output combinations. As a result, dieselized equipment in every phase of industry is working through Twin Disc torque converters—and gaining distinct performance advantages, from both single-stage and three-stage designs, combined with certain other exclusive features.

By automatically and instantly providing an infinite variety of ratios—in exact proportion to the load demand—Twin Disc torque converters eliminate lugging and stalling on diesel engines, permitting them to operate within their governed horsepower range. By transmitting torque entirely through fluid mass and motion, mechanical connection is eliminated—and load shocks, vibrations, jams, jars and torsional variations are effectively cushioned out between driving and driven equipment. Severe starting loads are picked up smoothly and easily, and heavy variations in running loads are automatically compensated for by the instant fluid "slip" within the torque converter.

Need for shifting, clutching and de-clutching is reduced to a minimum through Twin Disc torque converters, resulting in more accurate control with less operator fatigue. Delicate "inching" or "holding" of the load, under power, is possible at all times, by simply manipulating the throttle.

Three-Stage

The three-stage design—incorporating three rings of turbine blades and two sets of reactor or stator blades—develops a very high torque factor; up to 6 times engine output torque when at stall.

Four sizes of Twin Disc three-stage torque converters are offered. The 10,000, 11,500, 13,800 and 16,000 Series. Through variable internal blading, a total of twenty-nine capacities is available. In addition, a wide variety of input and output combinations is available. A variety of types is provided, including the truck-type models DF and CO and the industrial types CF, IF, and F.

TRUCK TYPES

Developed specifically for heavy-duty off-highway trucks, the Models DF and CO Truck-Type Torque Converters provide performance characteristics for distinctively different applications. The Model DF is designed for hauling situations involving both variable terrain and long, flat stretches. Here, the Model DF is used for its finger-tip controlled Converter Drive; Converter Braking; and Lockout Drive for better speed and fuel economy over flat terrain. To climb a steep grade, the operator flips his manual control switch to Converter-Drive—and gains advantage from the up-to-6:1 torque multiplication. For Converter Braking, both the inner and outer oil-actuated clutches are engaged, causing the truck wheels, then, to drive the converter, direct drive shaft and engine. With the engine compression and friction combined with the energy absorption of the converter impeller, powerful, effortless braking is realized.

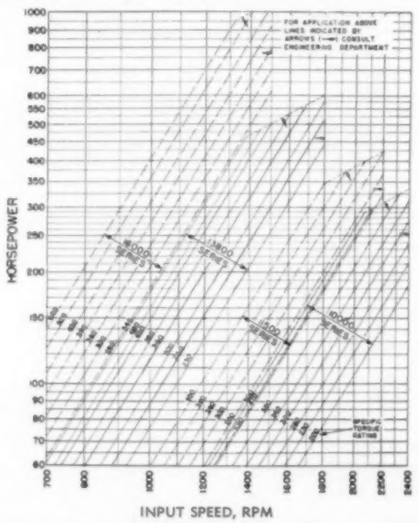


Chart indicating capacities of the four Series of Twin Disc Three-Stage Torque Converters.

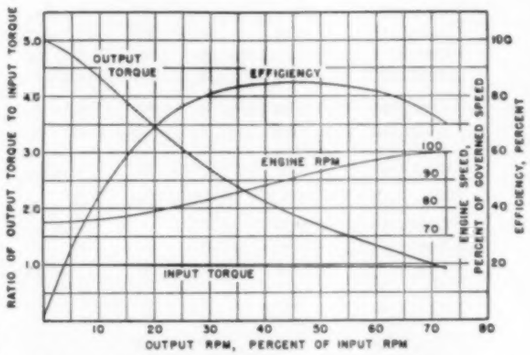


Chart showing how maximum efficiency of Three-Stage Torque Converter is obtained when output speed is one-third to two-thirds of input, and how torque multiplication diminishes as output speed approaches that of input.

On long, straight runs where maximum speed and economy are desired, the Model DF is switched to Lock-out Drive. This causes oil pressure to engage the Model DF's inner clutch, which provides mechanical drive without rotation of the hydraulic torque converter.

The Model CO Truck-Type Torque Converter—used primarily in situations involving constant climbing and descending, as in mining—does not include Lock-out Drive, as this feature is not needed under such hauling conditions. Since torque multiplication and downhill braking are

the primary requirements for such applications, the Model CO is designed for accelerator-controlled Converter Drive and Hydrodynamic Braking. Both are instantly and automatically brought into use by the operator depressing or raising his accelerator. On both Twin Disc Truck-Type Torque Converters, Hydrodynamic Braking and Converter Braking are built-in, and do not require additional installation problems, excessive exterior piping, or wasted space.

Single-Stage

Twenty-eight years of designing, building and applying three-stage torque converters, plus years of intensive engineering and field testing—recently resulted in the introduction of a new line of Twin Disc single-stage torque converters. The single-stage design—incorporating one ring of turbine blades and one set of reactor or stator blades—develops a mild torque factor; up to 2½-3 times engine output torque when at stall. Two sizes of Twin Disc single-stage torque converters are currently available—the 1300 and 1500 series. The 1300 series is applicable to engines producing from 30 hp at 1450 rpm to 212 hp at 3200 rpm. The 1500 series is for applications from 30 hp at 1100 rpm, to 207 hp at 2500 rpm.

Industrial Engine Types

To meet the requirements of other types of industrial Diesel-powered equipment in construction, logging, petroleum, marine, and other industries—on crawler tractors, power shovels, hoists, cranes, excavators, yarders, loaders, winches, barkers, rotary drives, drawworks, slush pumps, etc.—Twin Disc has provided a variety of input and output ends for any single or compound Diesel application.

THREE-STAGE

The model IF is independent-mounted, with either narrow or wide chain housings for the output end. It is available in series 10,000 and 11,500.

The model F torque converter has a flange-type input, and bolts directly to the engine flywheel housing, with no clutch. It is available in series 10,000, 11,500, 13,800 and 16,000. The model CF industrial-type torque converter bolts directly to the engine flywheel housing, and provides a clutch between engine flywheel and converter pump wheel. The model CF is available in series 10,000, 11,500, 13,800 and 16,000.

All three Industrial-Type Models—IF, F, and CF—offer five different output combinations. Output Type A is a narrow-chain housing; Type B is a wide-chain housing; Type C[1] is a straight shaft for direct connection to the driven load; Type C is a flanged shaft for "U" joint connection to the propeller shaft; and Type C[2] is a heavy-duty direct-connected rear end.

SINGLE-STAGE

Currently the 1500 series Twin Disc single-stage torque converters are available in four distinct models: (1) model "C," with clutch input; (2) model "S," with spider drive input; (3) the spacer-type model "S," with double-ended SAE housing; and (4) model "U," with flange input and flange output. The 1300 series is currently offered as a Model "F" unit.

Heavy-Duty Friction Clutches

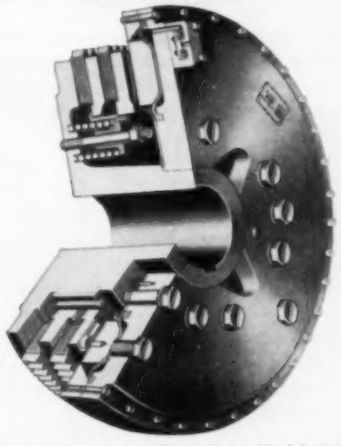
Engineered for extra heavy-duty Diesel applications, Twin Disc Models E and EH Friction Clutches incorporate the latest features in clutch design, providing greatest possible ruggedness to withstand heavy shock loads and heat. Overall dimensions are held to a minimum, to conserve space in installation. Maximum bores are provided, large enough to accommodate oversize shafts for corresponding requirements.

Twin Disc Model EH Heavy-Duty Friction Clutch.

Fully enclosed, Models E and EH Clutches are protected against dust and dirt, and permit operation in the open without requiring special guards and housings.

One-, two- and three-plate construction are offered, in sizes 14" to 36". Working capacities of Twin Disc Models E and EH Heavy-Duty Friction Clutches are from 13.5 to 350 hp per 100 rpm.

Air Clutches



Cross-sectional view of Twin Disc Model PO Air Clutch, showing compact construction for installation within less shaft space.

Newly designed, the Model PO Air Clutch offers lighter, more compact remote control of power transimission without complicated linkage. Greater torque capacity (up to 126,600 lbs. ft.) reduces initial installation costs, in many instances, through use of smaller size clutches. Lighter weight reduces shock-loading during starting cycles, permitting use of smaller driven components. Narrower width permits more compact installation, and use of the Model PO where, previously, drum or band style clutches with larger diameter and higher inertia were only solution. Positive, quick release is provided by exclusive Twin Disc diaphragm design—fully-supported, with no-stretch construction—and with extra-long stroke and controlled flexing. Extra-large air-passages cool vital working parts for long, trouble-free operation. Available in sizes 8" through 36".

Fluid Couplings and Fluid Power Take-offs

For dieselized installations where protection is needed against lugging and stalling during load starts—and against shocks, jars, vibrations and torsional variations during operation—Twin Disc offers a complete line of Fluid Couplings.

Unlike the Hydraulic Torque Converter, Fluid Couplings do not multiply the output torque of the engine. Instead, they are more applicable for equipment starting under medium loads, and where increases in the running load provide time for proper gear selection or load adjustment.

Twin Disc Fluid Couplings do, however, transmit full output torque of the engine at all output speeds—and through the "slip" within their fluid circuit, they provide a constant cushioned effect which eliminates the undesirable operating characteristics of mechanical drive. Acceleration is uniform; excess wear and breakage in belts, chains, gears, and drive lines is reduced; and distribution of the load on compounded drives is markedly improved.

Twin Disc Fluid Coupling, Stamped Steel.

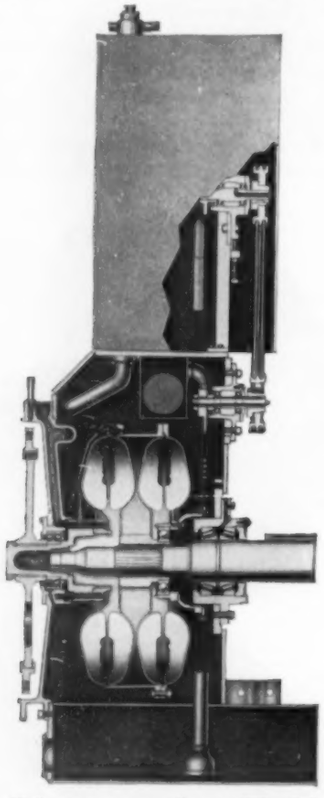
Twin Disc Fluid Power Take-Off.

Outstanding construction features of Twin Disc Fluid Couplings include Twin-Circuit design, through two impellers instead of one, to provide greater capacity in proportion to size and permit more compact installations. Twin-Circuit design also eliminates end-thrust on bearings. Another feature is the flattened out torus or core ring,

combined with circuits inclined toward each other. These features help reduce the weight of the unit, and also reduce oil capacity to 15% less than similar units with straight-sided circuits.

The new Fluid Coupling line is available in ten different models, in both cast-aluminum and stamped-steel construction, with sizes ranging from 7.4S to 27 and capacities up to 850 horsepower. A variety of input and output combinations makes them applicable to any type dieselized hook-up.

Twin Disc Fluid Power Take-Offs provide the same performance characteristics as the Fluid Couplings, and are speeding up work cycles in many types of powered equipment—by improving engine performance and permitting the operator to crowd the load more effectively. Construction of Fluid Power Take-Offs combines the basic Fluid Coupling with a cast bell-housing, bearings, and output shaft. Available in sizes 14.5 through 21.



Disconnecting Fluid Power Take-Offs

For heavy-duty dieselized equipment requiring disconnect from the load, Twin Disc provides the Model HUD Disconnecting Fluid Power Take-Off. By eliminating mechanical connection, the Model HUD prevents slow-speed lugging or killing of the engine. Shock loads are reduced up to 70% or more. Full use of peak torque from Diesel engines is permitted. Compounded loads are balanced. Vibrations and shock loads are cushioned out. Operational life of chains, clutches, and other running parts is often doubled. Need for a master cut-off clutch is often eliminated. And hovering or "inching" of the load is provided, through fluid "slip."

The Model HUD is available in Models 21 and 27 for up to 850 horsepower, with integral cooling unit provided.

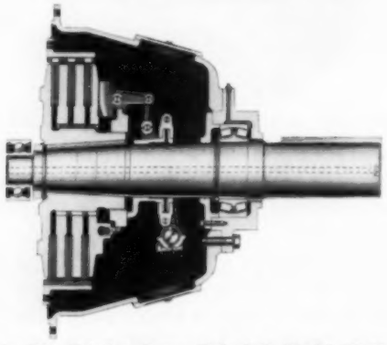
Power Take-offs and Reduction Gears

For any Diesel application up to 600 hp, Twin Disc Friction Power Take-Offs offer rugged, dependable power transmission with trouble-free operation.

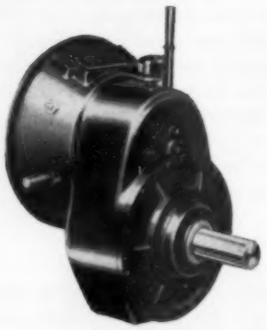
Newest of friction power take-offs is the SP line. It is specifically developed for today's higher horsepower, and rpm engines, and is offered in single, double or triple drive-plate construction.

Easy assembly to engines is provided by Twin Disc's unit design, consisting of a complete clutch power take-off assembly with shaft and bearings mounted in a rigid cast-iron housing. Conservative rating—in keeping with Twin Disc policy—assures actual torque capacity of the clutches to be far in excess of the rating listed. This provides long life and the ability to withstand temporary overloads and moderate slippage over short periods, without permanent damage.

Twin Disc Model HUD Disconnecting Fluid Power Take-Off, with integral cooling unit.



Twin Disc Friction Power Take-Off, Model SP-321.



Twin Disc Reduction Gear.

Twin Disc Power Take-Offs are easily installed on any Diesel engine with standard SAE flywheel housing dimensions, from No. 6 SAE to No. 00 SAE. Clutch sizes range from 14″ to 21″, triple-plate; 11.5″ to 24″, double-plate; 6.5″ to 24″, single-plate.

Twin Disc Reduction Gears combine a complete clutch power take-off assembly with a reduction gear, assembled into a single unit. They are used on Diesel installations where shaft speeds required for driven equipment are lower than engine rpm. Applicable with either direct drive, chain sprockets or pulleys, they are installed on Diesel engines with standard SAE flywheel housing dimensions—No. 6 SAE to No. 0 SAE. Clutch sizes range from 6.5″ single-plate to 14″ double-plate. Horsepower capacities range up to 140.

Marine Reverse and Reduction Gears

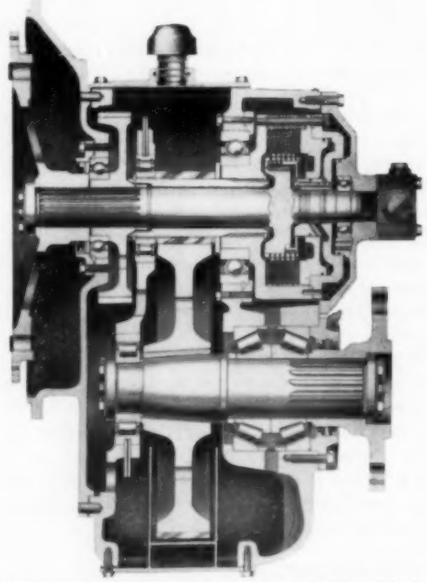
Twin Disc offers a complete line of Marine Gears for Diesel-powered boats up to 340 horsepower, with optional and exclusive features offered to provide better maneuverability, smooth, quieter operation and longer wear-life.

Fluid Coupling-equipped Marine Gears are available in the Model MGH-340, which eliminates mechanical connection, dampens engine torsional variations and propeller shocks, and cushions the shift from forward to reverse. Rubber Block Drive is available in the Models MG-511 and MG-302, with rubber-in-compression to cushion boat operation and withstand reasonable misalignments without excess strain.

A FULL RANGE OF SIZES

Based on continuous engine output rating

Model	Hp. Capacity	Engine Rpm.
MG-61	40-110	900-2500
MG-165	125-185	1200-2100
MG-166	125-195	1200-2100
MG-200	90-225	600-1500
MG-201	120-180	600-1000
MG-302	150-275	600-1500
MGH-340	185-340	700-1500
MG-511	100-240	1000-2100



Model MG-511 Marine Gear, with Rubber Block Drive.

Compact in design, Twin Disc Marine Gears combine a heavy-duty duplex clutch for forward and reverse with an integral reduction gear. Operation at full-power and speed in either direction of rotation is provided, permitting 100% reverse operation over extended periods.

TORQMATIC DRIVES

GENERAL MOTORS
ALLISON DIVISION

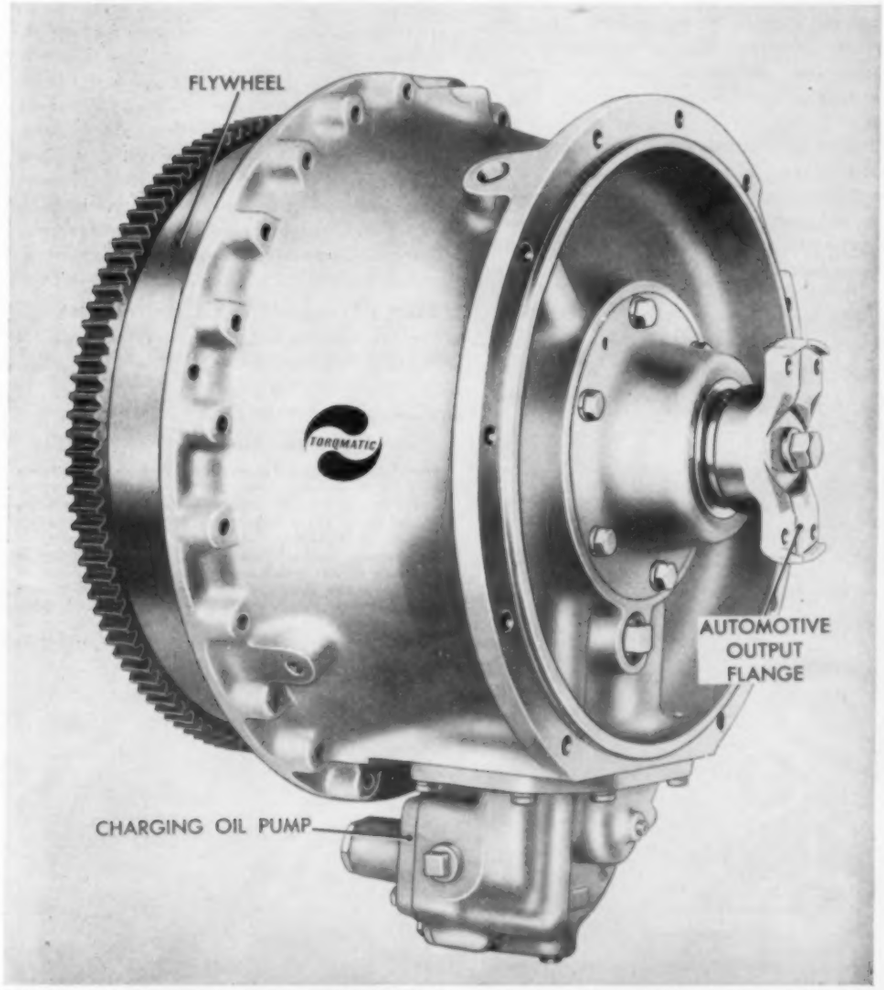
The sign of the Torqmatic swirls marks Allison's trade name for its TC torque converters, TCB converters with hydraulic retarder, TG transmissions, CT converter-transmissions, RC rail car transmissions, and the marine gear.

Many equipment "families" are included in the Torqmatic drive, field of application: in earth moving and construction—shovels, draglines, scrapers, loaders, tractors, dozers, drill and pile drivers, ditchers, trenchers and rock crushers; in mining—locomotives, loaders and trucks; in material handling—cranes, rail cranes, hoists, derricks, fork lift trucks and straddle carriers; in logging—yarders and loaders; in transportation—switching locomotives, rail cars and buses; for road work—compactors, road rollers, motor graders, snow plows, sweepers and asphalt spreaders; in oil field operations—drill rigs (stationary and mobile-hydraulic fracturing, cementing, service rigs and oil field "logging" exploration; in Marine applications—fishing boats, tug boats and pleasure craft; in off-highway hauling—ore haulers, coal haulers, earth haulers, log haulers, crane haulers, wheel or track transporters, tow tractors and ski tows.

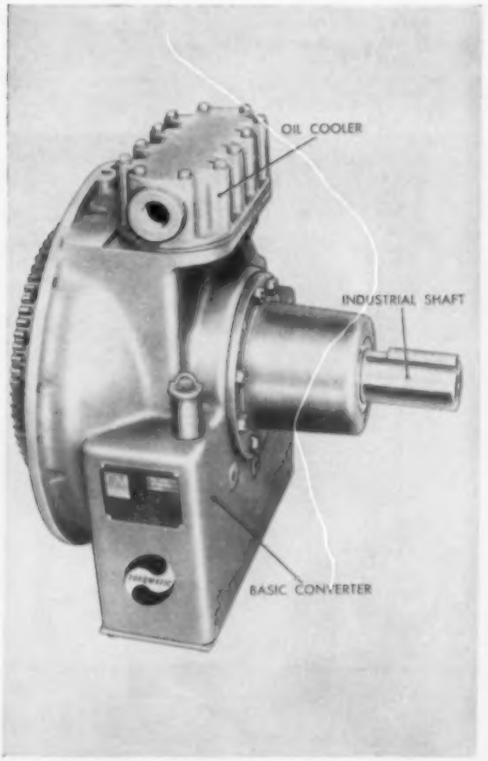
The Allison Torqmatic converters cover a horsepower range from 40 to 400 with three basic housings, or three diameters. They are the TC-200, -300 series, the new TC-500 series (which replaces the former -400, -600 and -840 series), and the TC-900 series Torqmatic converters. These three basic housings offer a total of 135 models for a variety of application.

For compactness and flexibility of installation, the Torqmatic converter-coupling incorporates the rotating housing principle. The overall length is practically the same as conventional power take-off, and comparable in weight. All combine the feature and advantage of automatic hydraulic torque multiplication and automatic fluid coupling when torque multiplication is not necessary. Their maximum torque ratios range from 2.0 to 3.6, depending on the model.

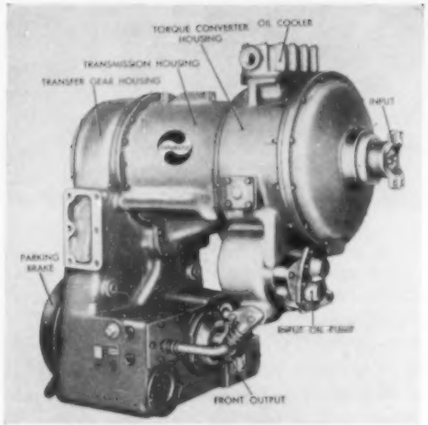
The TC-200 series is a three-element converter (pump, turbine and stator); the -300, -500 and -900 series are four-element converters using two stators instead of one. The turbine is single stage, which means that the oil passes through its blading only once in one complete circuit through the



Model TC-500 Torqmatic converter-coupling which replaces the -400, -600, and -840 series. It includes either an automotive flange or an industrial shaft. The TC-500 Torqmatic makes possible one diameter for many different engines, greater parts interchangeability for a variety of installations, and a wider performance range coverage. The TC-500 covers the 125 to 300 hp range, and can be had with or without hydraulic input disconnect, manual input disconnect, hydraulic lockup, hydraulic output disconnect, hydraulic retarder, and governor drive.



Model TC-300 four-element, Torqmatic converter-coupling with industrial shaft and integral oil cooler. The 300 series converter has the same physical dimensions as the three element 200 series, the difference is in torque absorbtion. The 200-300 series covers a 40 to 125 hp range for Diesel engines. These converters can be had with or without oil cooler, front-disconnect clutch and adapter, rear-disconnect clutch adapter, automotive flange, industrial shaft, and governor drive.



Model CRT-3330 Allison Torqmatic transmission is a self-contained transmission package, combining the Torqmatic converter with the Torqmatic planetary gearing and transfer gearing. It provides 3 speeds in both forward and reverse ranges with quick full-powershifts needed for loaders, graders, and fork lift trucks. Its hydraulic control provides a new SENSE-FEEL for "feeling" the load when reversing direction. Either one or two outputs are available. The front output incorporates a mechanical disconnect clutch, and the rear output a drive line parking brake.

converter element. The stators are free-wheeling —operating on the over-running clutch principle. The free-wheeling stators are the key to the coupling feature of the Torqmatic converter. The over-running clutch principle permits the stators to rotate when torque multiplication is no longer necessary. Also, the use of the free-wheeling stators results in a smooth output horsepower curve by blending the transition points between the converter phase and coupling phase.

Where the torque ratios of the Torqmatic converter alone are sufficient, the Torqmatic converter-coupling can be used in many applications without a transmission. Such applications are: cranes, shovels, draglines and locomotives.

In cranes, the Torqmatic converter gives the operator perfect control to move the load up or down a fraction of an inch by simply moving the engine throttle—no clutching, declutching or friction braking is necessary when moving the load. With friction clutches in cranes, it is often necessary to slip the clutch at full throttle to start heavy loads. This practice, which often results in a burned or warped clutch and high maintenance costs, is entirely eliminated with Torqmatic converters.

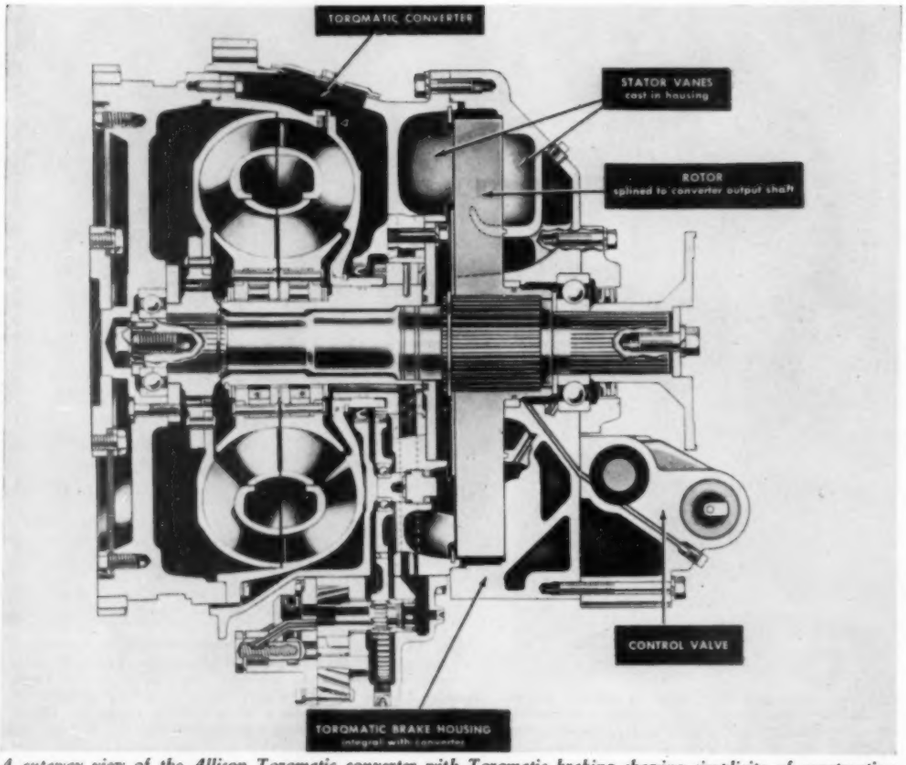
Another advantage obtained with Torqmatic converters in shovels, draglines and backhoes is that engine speed will not fall off detrimentally because of momentary overload. The instant the bucket is slowed down by a load, hydraulic torque multiplication increases automatically within the converter. This enables the operator to maintain a steady pace in moving the maximum amount of dirt that the unit is capable of handling. The Torqmatic converter is like a floating fulcrum which automatically adjusts to provide the best leverage and speed to move the load. Also, the Torqmatic converter protects the engine and equipment from the extreme shock loads common in this type of operation.

At all times the Torqmatic converter permits the engine to operate at its most effective output because the converter makes available more power over a wider working range. This allows more work to be done in a given length of time. Thus, in a given installation, it is possible to use a smaller engine with the Torqmatic converter than could be used with "pre-Torqmatic methods" of power transmission.

For applications requiring higher range of torque ratios, Torqmatic drive offers the combination of a matched team (up to 16:1 torque ratio) TC converter and TG transmission, or a single unit which houses the converter, transmission, and drop box in one package—the CT series of Torqmatic converter-transmission (up to 46:1 torque ratio). The "infinitely variable" number of torque ratios provided by the Torqmatic converter is further extended by this full-power, quick-shift principle of the Torqmatic transmission. This combination of converter and transmission paired as a team, or housed in one unit, makes possible the most efficient gear ratio. Whether a separate converter and separate transmission are employed, or the one unit converter and transmission package is used, both types of installations require only one common hydraulic system for converter and transmission.

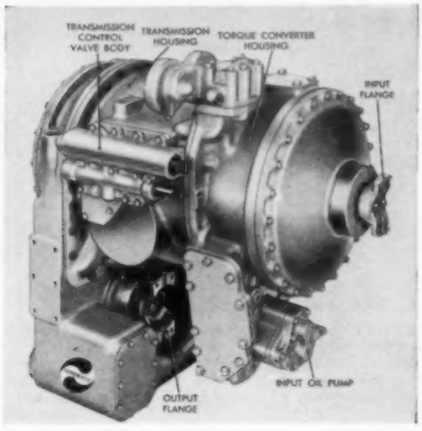
The TG series of Torqmatic transmissions comes in three basic models from which over 70 variations can be obtained for diversified applications. These models vary from a straight-thru drive model for installations not requiring accessory drives, to models with countershaft drives, and to models with front and rear drive lines, power take-off included. The many variations available include output flanges, right hand or left hand rotation, self-contained output shaft disconnect clutches, transfer gear ratios (0.76:1 and 1:1), solenoid control range selector for remote operation, push start pump, and provisions for mounting drum-type or disc-type drive line parking brake.

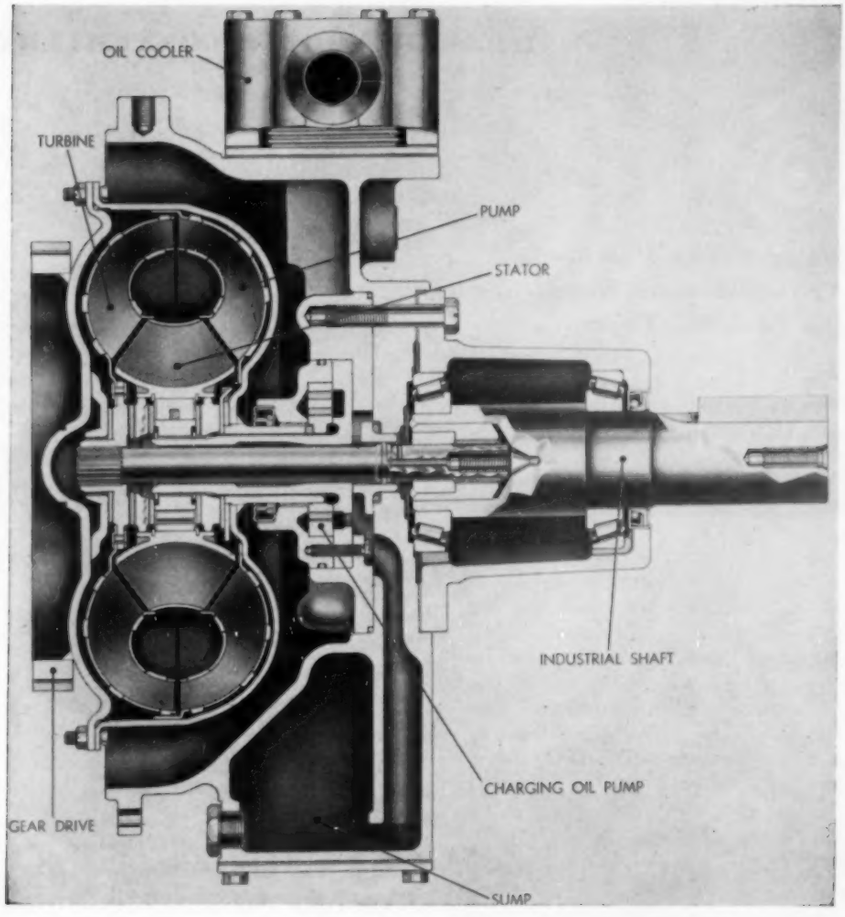
The CT Torqmatic transmission combines the converter-coupling and quick-shift transmission advantages into one housing. In addition many

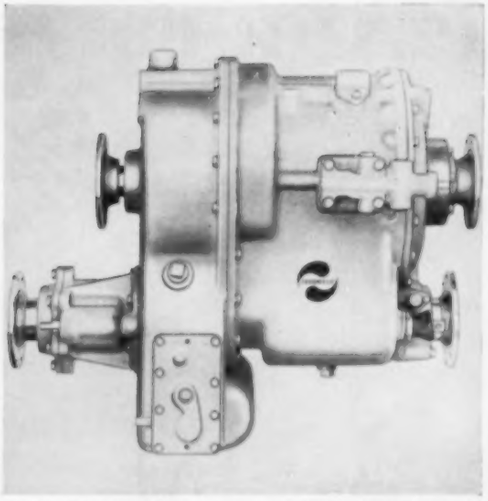


A cutaway view of the Allison Torqmatic converter with Torqmatic braking showing simplicity of construction and compactness of design.

Model CRT-5630-2 Torqmatic transmission (3 speeds forward, 3 speeds reverse). Converter, range gearing and transfer gearing are contained in one package. Model shown is for remote engine mounting. Another version of this series provides for direct mounting to the engine flywheel housing. Torqmatic braking is available as an option and adds only four inches in length to the compactly designed unit. Maximum torque converter ratio is 3.6:1. The transmission gearing and transfer gearing ratios are low forward—3. 04:1; low reverse—3. 17:1; high forward—0.076:1; high reverse—0.79:1.







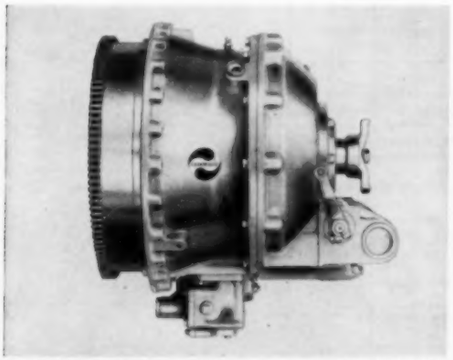
Model TG-647, like its counter part TG-627 Torqmatic transmission, was designed for mobile service in the oil field —for over-the-road and over-the-hole operations. Disconnect clutches can be operated independently. The TG-647 is designed for mobile units requiring two full-power take-offs opposite each other, and one power take-off opposite input, which drives auxiliary equipment. This transmission is for servicing rigs. The TG-627 is especially for processing pumps requiring two full-power take-offs on the same end and rotating in the same direction at the input drive.

Cross section shows the new, "three element" Allison 200 series Torqmatic converter available with either industrial shaft or automotive flange. Like the "four element" 300 series, the 200 series is completely self-contained. It includes oil cooler, integral oil lines and a conventional internal-external drive gear as used in clutch power take-offs. This results in flexible, easy installations—taking no more space than that used by conventional power take-offs. When torque output equals load demand, the converter acts as a fluid coupling to conserve fuel and boost engine and equipment life.

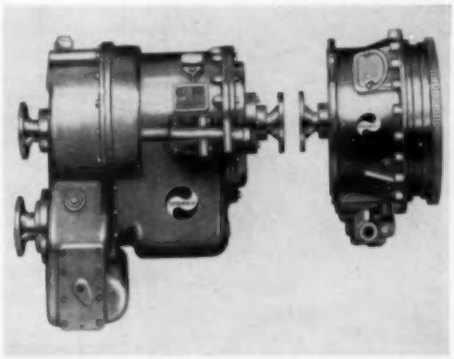
other exclusive performance features have been added—such as "SENSE-FEEL" forward and reverse clutch for "feeling" the load pick-up, 3 speed ranges in both forward and reverse, hydraulic braking, and other advantages, depending upon series and model. The CT transmissions are designated as the 3000 series and 5000 series, and are available with counter shaft drive or with straight-thru drive, and with governor drive or speedometer drive depending on model. Prefix letters and numbers in place of the ciphers indicate specific models.

Although the problem of faster, smoother, less costly load movement had been solved by Torqmatic drives, one problem yet remained: how to speed up the job cycle time— particularly on down grade hauls. In such operations the conventional friction brakes, by their very construction and limitation, must hold the load to a crawl—and brake shoe replacement is high. Integral with the converter, the hydraulic retarder is primarily used in vehicles equipped with the Torqmatic transmission. This in-the-drive-line retarder gives off-highway vehicles continuous braking power when most needed—on downhill hauls with heavy loads.

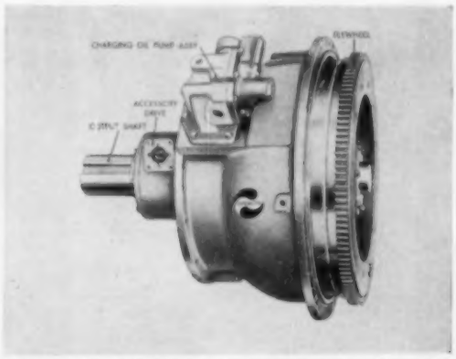
The driver has positive control at all times and can select any one of 3 speed ranges of the Torqmatic transmission with the hydraulic retarder continuously applied. It saves the service brakes for complete stops or "snubbing" on curves. Capable of absorbing approximately 400 bhp., depending on the operation, this retarder has only one moving part—rotor, or "paddle" wheel. The same oil that drives the vehicle brakes the vehicle.



Model TCB-500 Torqmatic converter-coupling with hydraulic retarder with automotive flange. Torqmatic rotor braking is designed for continuous braking in any gear range, subject only to the limitatons of the drive system.



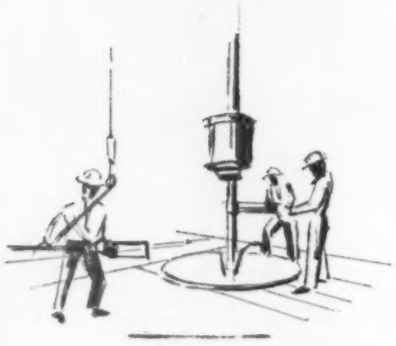
Torqmatic drives teamed to work together as a unit. The TG-600 Torqmatic transmission extends the advantages of automatic, hydraulic torque multiplication of the Torqmatic converter, and with the flick of the wrist, adds the full-torque shifting under load feature. Drive flanges are available for popular makes of propellor shafts. Available are straight-through drive and front- and rear-countershaft drives, with or without power take-offs and speedometer drive.

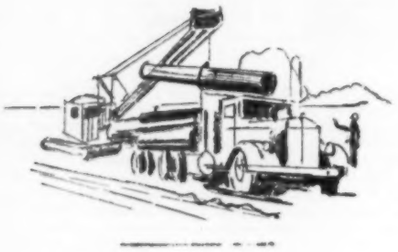


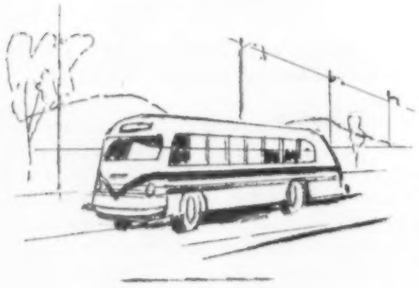
Model TCA-900 Torqmatic converter-coupling with industrial output shaft and accessory drive. Like the 300 and 500 series, it is a four-element converter. All series employ the rotating housing principle. The TC-900 series covers the 300 to 400 hp range and can be obtained with hydraulic input disconnect, lockup clutch in the converter, an accessory drive on the output for tail shaft governors, automotive flanges and industrial shafts.

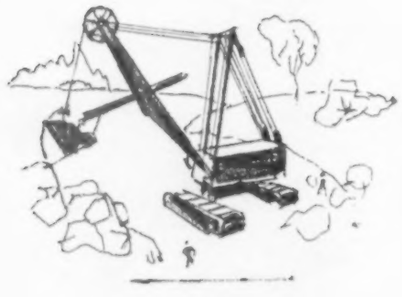
CLARK EQUIPMENT

HYDRAULIC TORQUE CONVERTERS









For Every Power-Transmission Need—a CLARK-Torcon

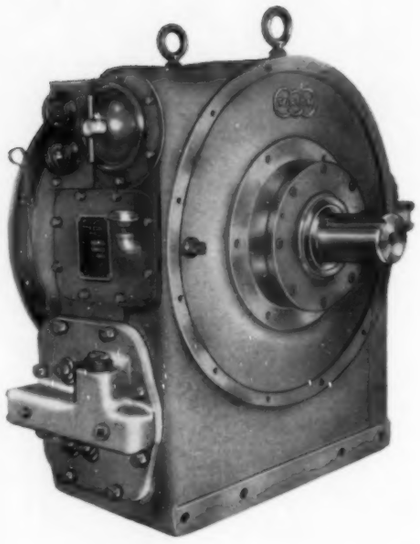
IN Clark-Torcon heavy duty torque converters Clark Equipment offers a complete line designed to meet every power-transmission need. Clark-Torcon units are widely used on highway and off-highway vehicles and for stationary units in construction, logging, drilling and other industrial applications.

A vital factor of the Clark-Torcon torque converter is that its operating characteristics are matched to those of the engines with which it is to be used. As a result, a Clark-Torcon unit enables the engine to operate within its most efficient range of speed and torque load; and engine wear is kept at a minimum. Clark-Torcon has a stall ratio of 3-to-1. Changing load requirements are met immediately, effectively and automatically.

SHOCKLESS POWER SAVES WEAR-AND-TEAR

Elimination of shock-loads characteristic of conventional power transmission means longer life for all working parts in a system that includes a Clark-Torcon. Shocks are absorbed in the torque converter, and the entire torque load is evenly distributed.

Clark-Torcon's self-contained oil circuit, with oil passages and oil sump cast integral in the housing,

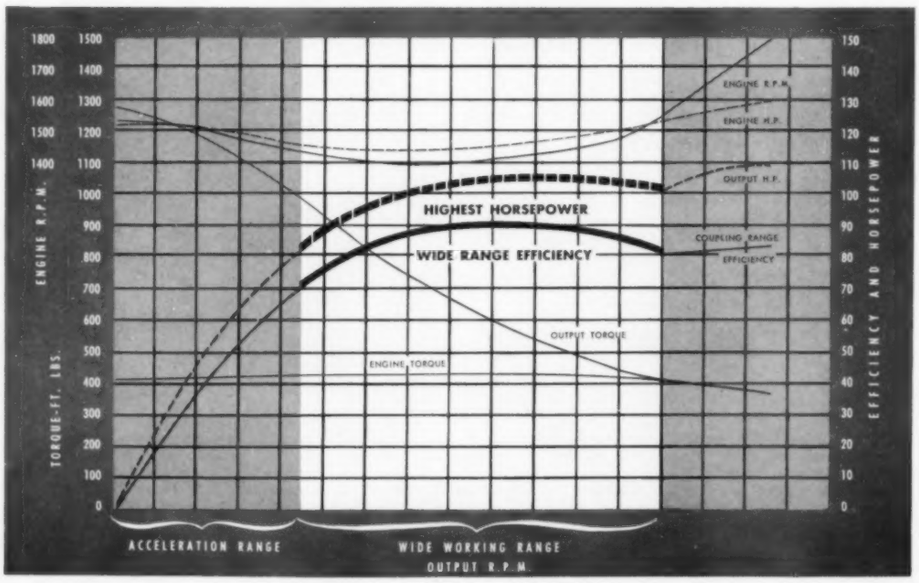


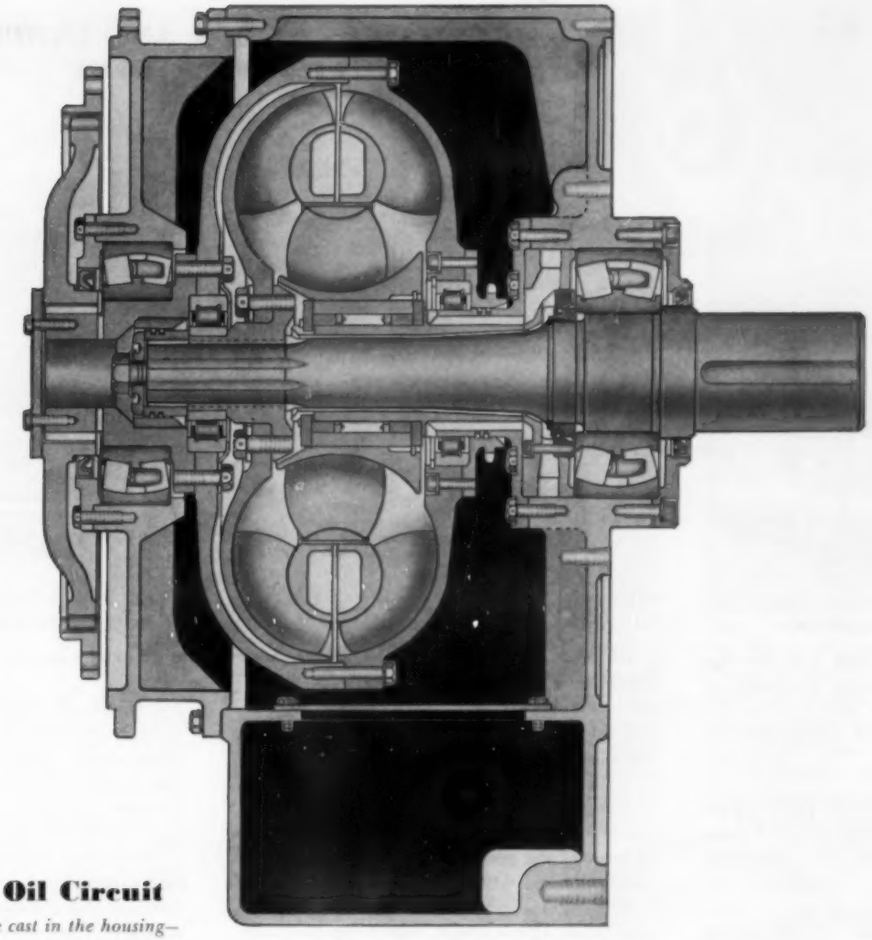
is an important factor in efficient operation and low maintenance. External fittings and complicated oil seals are unnecessary, and leakage is practically unknown. Maintenance is easy—ample-sized inspection plates are readily removable, with no need for special tools.

WIDE RANGE MEETS EVERY NEED

The Clark-Torcon converter is a complete unit including sump pump, and pressure regulator; with rated capacities from 15 to 600 horsepower, and a

Typical Performance



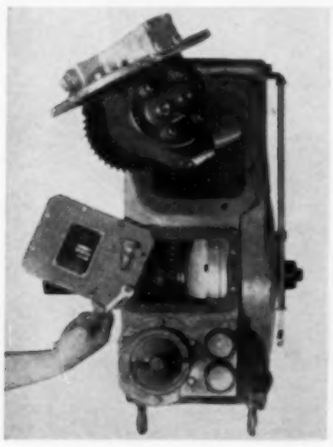


Self-Contained Oil Circuit

Oil sump and oil passages are *cast in the housing*—no external seals, no unnecessary fitting, no leaks.

Easy Maintenance

Quick, easy accessibility to all working parts is provided by ample sized inspection plates.



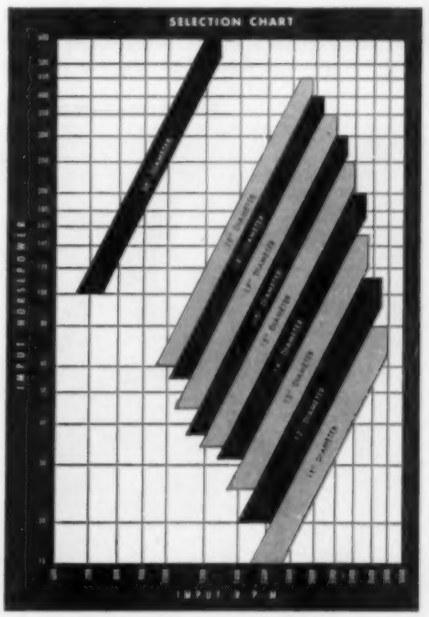
broad selection of wheel-diameters from 11 to 26 inches. It is mass-produced; and is available both to equipment manufacturers and to operators for field installation to up-date equipment in use. For special applications, Clark will design and build the housing or case.

"FREE WHEELING" FEATURE OPTIONAL

An important optional feature of Clark-Torcon is a "free wheel" mounting for the stator or reaction member, to provide the combined advantages of torque converter and fluid coupling. Under load it provides the desired torque multiplication. When load decreases and speed increases, torque multiplication drops to "one," and the unit acts as a fluid coupling. As a result, an engine can be operated at uniform high efficiency throughout a wide working range, considerably above average performance. This feature is often recommended for equipment operating at low load and high speed through much of the work-cycle.

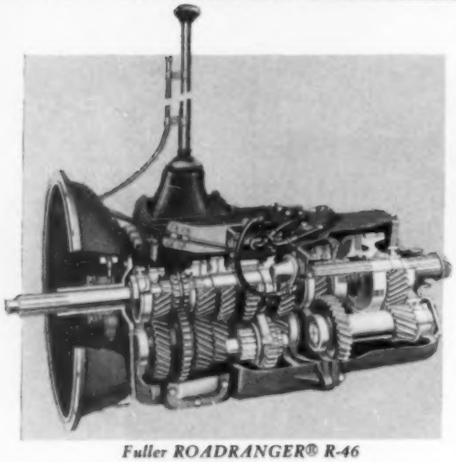
These Clark-Torcon torque converters are true quality products, manufactured by precision methods to close tolerances in a plant recognized as the last word in modern efficiency. Back of them is the strength of Clark Equipment Company, with its half-century-plus of engineering resources focused on engine-power transmission.

HP-15 to 600; Diameters 11" to 26"

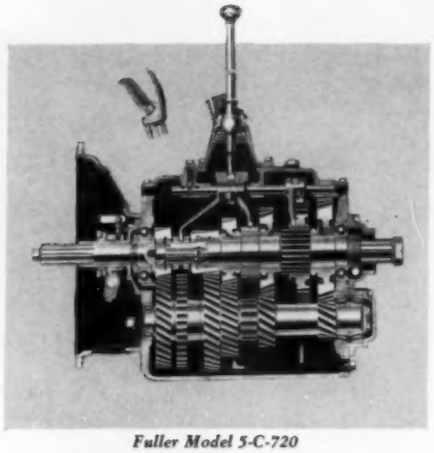


FULLER

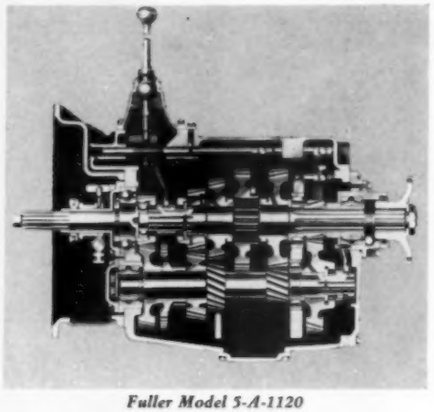
HEAVY DUTY TRUCK AND INDUSTRIAL TRANSMISSIONS



Fuller ROADRANGER® R-46



Fuller Model 5-C-720



Fuller Model 5-A-1120

THROUGH constant research and development, Fuller Manufacturing Company of Kalamazoo, Michigan, has set the pace for the rapidly widening application of transmissions to more powerful Diesel engines.

In addition to the recent extensive plant expansion of Fuller facilities—which has included three new structures and production line modernization—Fuller has expanded its transmission and auxiliary line to handle engines up to 1440 cubic inches. Fuller now offers a complete line of 108 different transmissions and auxiliaries.

The Semi-Automatic R-46 8-speed RoadRanger has been designed for over-highway operation in the 100-150 hp class. By using a 4-speed shifting pattern twice through a pneumatic power-shifted auxiliary, all 8 forward speeds are obtained with one gear shift lever.

For over-the-highway trucks and tractors equipped with Diesel engines in the popular 150-200 hp class, Fuller has continued to improve the five speed 5-C-72 and the 5-C-720. The latter adds the flexibility of overdrive. As with all Fuller transmissions, the 5-C-72 and 5-C-720 feature all-helical forward gears, low tooth pressures, short installation dimension, and low ratio of weight to capacity.

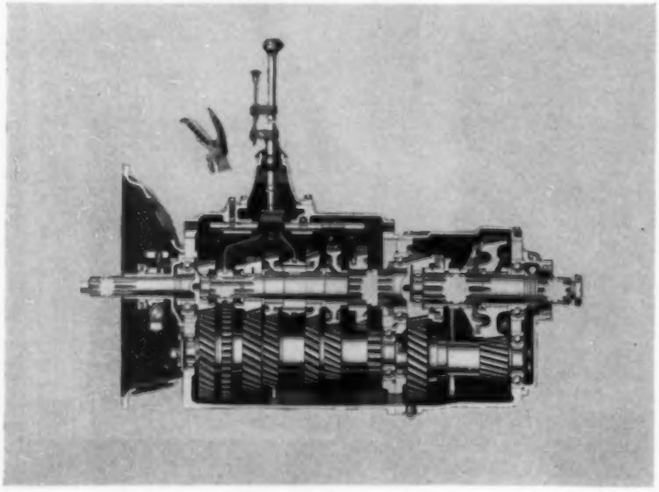
The original 10-speed RoadRangers, Models R-95-C and R-950-C, have been retired from production in favor of the new improved semi-automatic 10-speed R-96 and R-960. These new 10-speed RoadRangers incorporate a power-shifted auxiliary actuated by an All-Air system. Both units have short, even steps, averaging 28% between ratios and the R-96 adds an overdrive gear to the one-lever-no-gear-splitting advantages.

One Fuller transmission which meets the challenge of a wide range of horsepower in either on or off-the-highway use is the "1120" series, designed to handle Diesels from 150-300 hp. The 5-A-1120 is an extra-large five-speed transmission, which has won wide acceptance in the extra heavy-duty field. The ten-speed units—10-A-1120 and 10-B-1120—are engineered combinations of Models 5-A-1120 and the huskiest two-speed auxiliaries of the Fuller line.

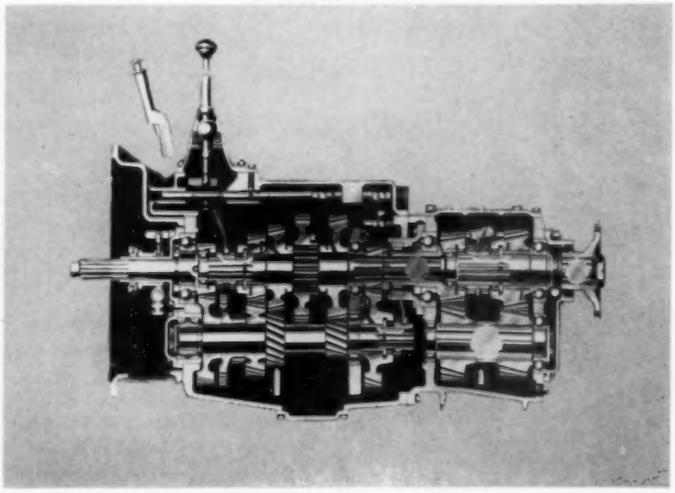
For Diesels of 200-300 hp—both on-highway and off-highway—Fuller offers the 4-speed Model 4-A-112 Transmission. Another contribution to heavy hauling progress, the 4-A-112 has been adopted as standard equipment on several lines of heavy earthmoving and open pit hauling equipment. It is particularly adaptable to applications where a high percentage of operation through gears in conjunction with auxiliaries is required. In combination with a three-speed auxiliary transmission, the 4-A-112 provides 12 forward and three reverse speeds. When used with a two-speed auxiliary, eight forward and two reverse speeds are obtainable. Fuller features all-helical gearing in all forward speeds in the 4-A-112 as well as in the 5 and 10 speed transmissions of the 720, 1120 and 1220 series. This assures high capacity with minimum weight—plus easy shifting to reduce driver fatigue.

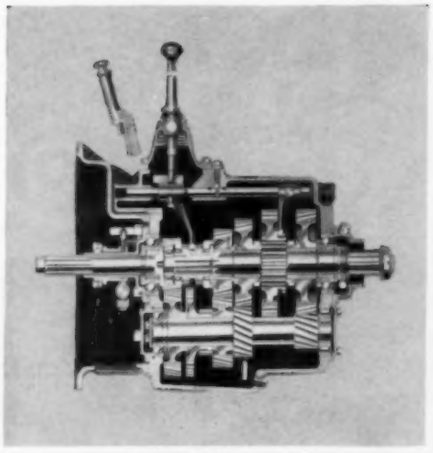
The new R-1150 Semi-Automatic RoadRanger Transmission provides 9 forward speeds with one gear shift lever. This transmission incorporates an

Fuller ROADRANGER® R-96

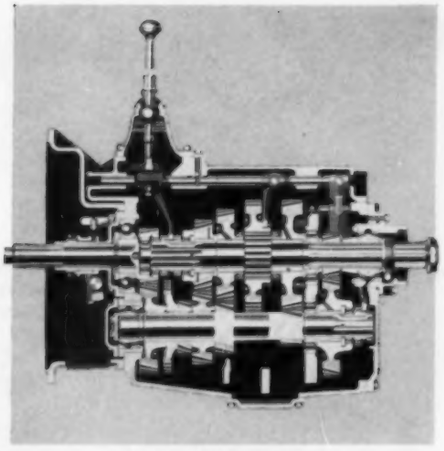


Fuller Model 10-B-1120

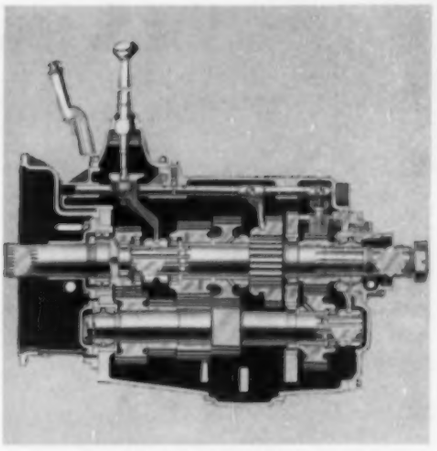




Fuller Model 4-A-112



Fuller Model 5-F-1220



Fuller Model 4-FS-1440

All-Air range shift control system to actuate the automatic 2-speed auxiliary. The R-1150 is designed for engines in the 1150 cubic inch class in off-highway applications where short, even steps between gear ratios have a definite operating advantage.

The Fuller "1220" series, for Diesel engines delivering up to 300 hp, includes the 5-F-1220, with five forward speeds, and the 10-F-1220, with ten forward speeds. Both units include overdrive for top speed as well as extra low gear ratios for steep pulls with extreme loads. Designed to provide highest capacity with minimum weight. The 5-F-1220 weighs 687 pounds; the 10-F-1220 weighs 982 pounds.

The Fuller 4-FS-1440 Transmission, developed for Diesel engines up to 400 hp, driving through Torque Converters, has met the test in such severe off-highway duty as open pit mining and heavy construction hauling. Its closely spaced gear ratios make new load-and-road performance possible in heavy-duty service. This unit is also available in amidship variations as Models 4-MS-1440 and 4-MB-1440. Bearings and gears of ample capacity for the most rugged jobs, allow the operator to make quick, smooth range shifts to fit the operating requirements. Weighing 775 pounds, the 4-FS-1440 provides an extremely high horsepower capacity on torque converter-equipped units.

One of the most outstanding auxiliary transmissions of the complete Fuller line, is the Model 3-T-92, a unit offering in one housing both a heavy-duty, three-speed auxiliary transmission and a full torque power take-off designed primarily for use with heavy-duty or five-speed transmissions. It provides both motive power and winch drive for heavy-duty trucks engaged in rigging, logging and other operations involving winch applications.

As an auxiliary transmission, the 3-T-92 provides three gear ratios for motive power—overdrive, direct and underdrive—thus assuring both the top speed and overall reduction necessary for operation either on or off-the-highway.

As a full torque power take-off, the Model 3-T-92, through its single unit construction, provides the utmost in capacity by eliminating the loosening and subsequent separation of units which sometimes occur in the combination of auxiliary transmission and top-mounted power take-off. All of the forward ratios available from the unit mounted transmission can be used through the full torque PTO shaft. In addition the rotation of the PTO shaft can be reversed, thus assuring a range of PTO ratios, either forward or reverse, corresponding to the ratios in the unit mounted job.

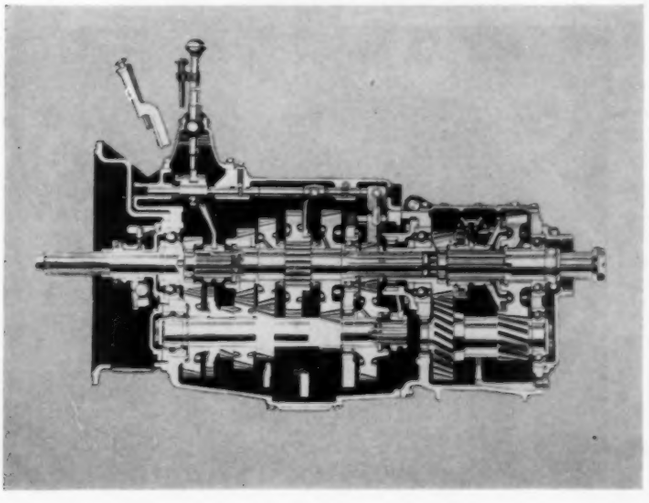
With the models mentioned, plus the great variety of other transmissions and auxiliaries in their line, Fuller is meeting today's challenge in modern dieselization. Designed for use with straight and tractor-type trucks engaged in heavy-duty transport . . . on-the-highway or off-the-highway operations . . . commercial trucks and trucks engaged in rigging, logging or other operations involving the use of winches . . . these heavy-duty unit-mounted and auxiliary Fuller transmissions provide a wide range of operation with extreme flexibility.

Fuller Transmissions for Diesel Applications

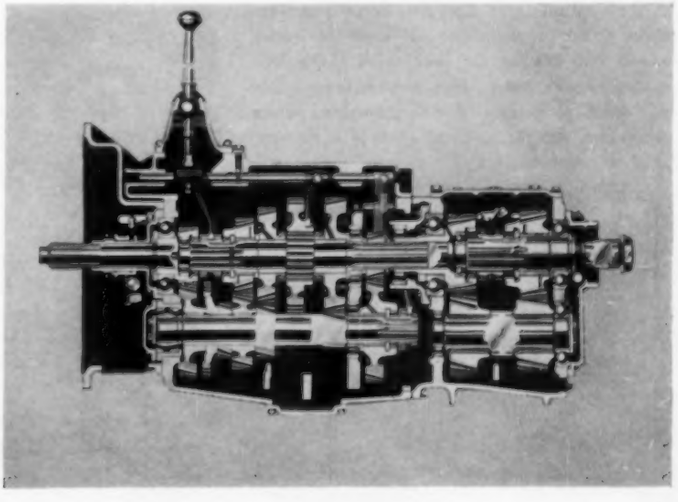
Models	Hp Capacity	Weight (lbs.)	On-Highway	Off-Highway
R-46	100-175	457	x	
5-C-72	150-200	465	x	
5-C-720	150-200	465	x	
R-96	150-300	767	x	
R-960	150-200	767	x	
5-A-1120	150-300	681	x	x
10-B-1120	150-300	960	x	x
10-A-1120	150-300	960	x	x
4-A-112	200-300	525		x
R-1150	to 300	1015		x
5-F-1220	to 300	687		x
10-F-1220	to 300	982		x
*4-FS-1440	to 400	775		x

*For use with Hydraulic Torque Converters.

Fuller ROADRANGER® Model R-1150



Fuller Model 10-F-1220



LINK-BELT

CHAIN DRIVES FOR USE WITH DIESEL ENGINES

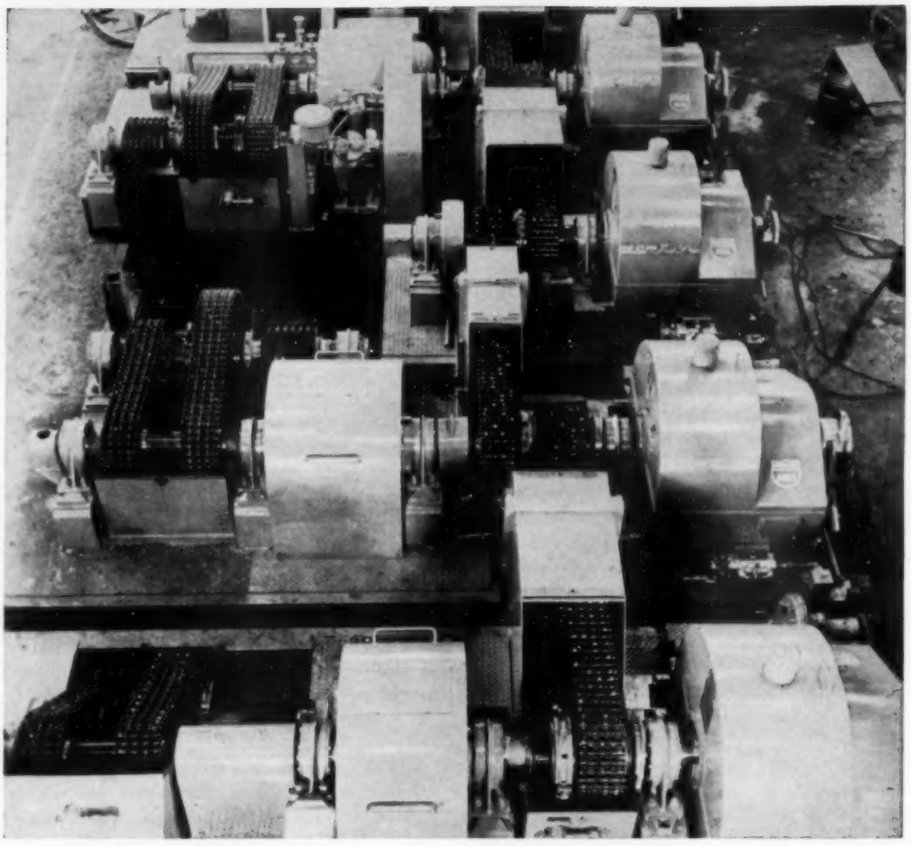
LINK-BELT Company has for many years produced precision-built power transmission chains for internal combustion engines, and offers to Diesel engine manufacturers a comprehensive complete line of both roller and silent chains.

Whether the problem is one of engine timing or one of engine auxiliaries, driving water and lubricating oil pumps, tachometers, governors, fuel supply pumps, exciters, generators, or air compressors, Link-Belt engineers can select a chain drive that is right for the purpose. To meet certain operating characteristics, silent chain may be the preferred selection, while in another case the use of roller chain may constitute the ideal application.

Chain drives have many advantages over other types of drives. Due to its flexibility, chain can be adapted to conditions that otherwise would necessitate complicated and expensive designs, requiring location of the driven elements at inconvenient and sometimes inaccessible points and resulting in higher manufacturing and assembling costs than when using chains.

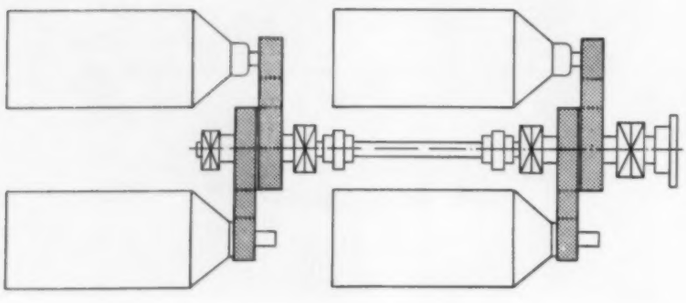
Chain drives permit laying out convenient, efficient, durable and quiet driving connections to camshafts, generators, compressors, blowers, governors, etc. They are quiet initially and remain quiet throughout their useful operating life. In the light of Link-Belt engineering developments in both silent and roller chain drives during the past several years, it is now possible to apply these chains much more broadly than ever before. Combinations of high speed and heavy load that were considered prohibitive a few years ago are now being handled very successfully with these chains.

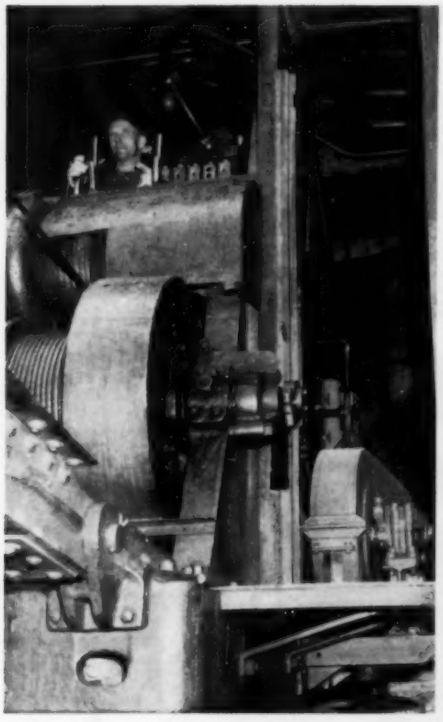
This knowledge and experience gained by Link-Belt engineers, combined with a long experience in the application of Link-Belt silent and roller chain drives to engines in all kinds of service, is also available for the solution of chain drive applications extending from engine to such outside driven elements as marine propellers, pumps, generators, and all types of oil field equipment, as illustrated here.



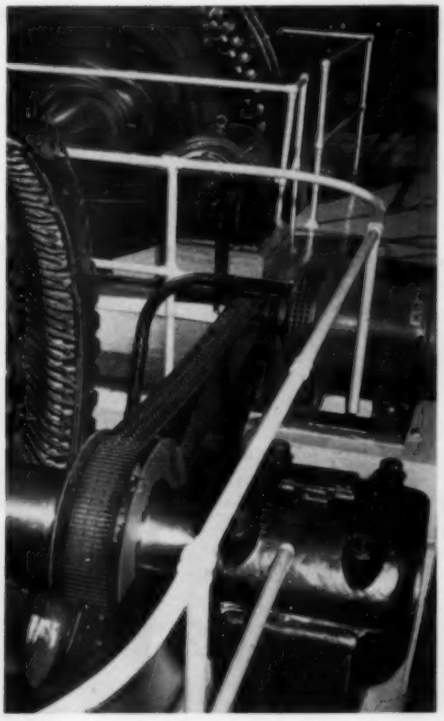
PRECISION STEEL ROLLER CHAIN. This 3,350-horsepower National 160 rig is compounded by means of quadruple widths of Link-Belt precision roller chain, the oil field choice of many heavy duty applications—especially where shock loading is a factor. The rollers on this Link-Belt chain are shot-peened, to give them exceptional fatigue life. Precision-controlled heat treating guarantees absolute uniformity of all chain parts.

SILVERSTREAK SILENT CHAIN. Four 175 hp. Cummins Diesel engines, made into a foursome multiple engine unit by Russell-Hipwell Engines, Ltd., are connected by four Link-Belt Silverstreak silent chain drives to a central drive shaft which is connected to a gearmotor. Lower left diagram shows relative location of engines and photo below shows two of the chain drives, with cover removed from casing. Link-Belt Silverstreak silent chain is built for long life and continuous operation at high speeds. Its proved efficiency of better than 98 percent is unaltered by wear, temperature and atmospheric conditions.

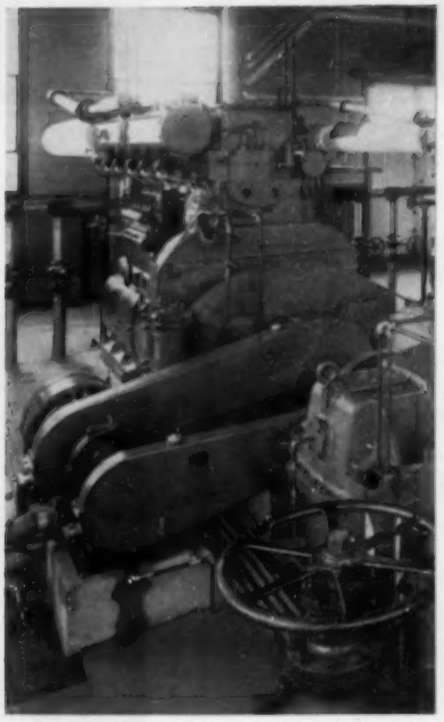




FOR CONVERSION—In converting 1916 steam-operated locomotive crane to Diesel, Link-Belt Silverstreak Silent Chain was chosen as the drive.



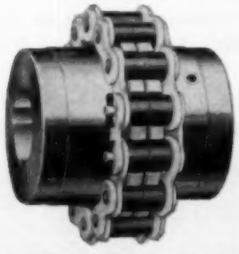
FOR EXCITER DRIVES—Full exciter rpm. is transmitted by Link-Belt Silverstreak Silent Chain drive to 560 hp., 840 kw. generator at municipal power plant.



FOR POWER TAKE-OFF—Link-Belt Silverstreak Silent Chain provides the drive from Diesel engine to pump and generator at pipeline pumping station.

LINK-BELT "RC" AND GEARED FLEXIBLE COUPLINGS

The Type "RC" coupling is rugged in construction, easy to handle, durable, reliable and efficient in service. It consists of two cut tooth sprocket wheels (or coupling halves) which are connected by a piece of specially constructed finished steel roller chain, using a patented divided roller feature, which combines the advantage of double roller chain with the more rugged and simple construction of single width chain. This coupling has great flexibility of design for meeting special conditions and requirements.



(Above) Link-Belt "RC" flexible coupling (without casing)

Fig. 1.

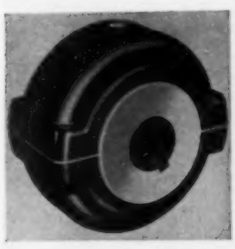


Fig. 2.

Divided rollers (patented) provide longer-lasting independent contact for each of the coupling halves, without sacrificing the simplicity and ruggedness of single-width chain assembly. Chain is precision-made from alloy steels of great toughness and strength. Coupling halves are machine-finished all over for proper balance at high speeds. Teeth are accurately cut to equalize load distribution, and hardened for added durability.

It is considered good practice to enclose and lubricate Type "RC" couplings because it affords a reduction in the friction coefficient between the sliding parts of the coupling, resulting in a more efficient direct drive connection. The housing and lubrication, while always desirable, are not definite requirements unless the couplings are required to operate under any or all of the following conditions:

1. Speeds above 500 rpm.
2. Dusty atmosphere.
3. Moisture-laden atmosphere, or subject to water splash.

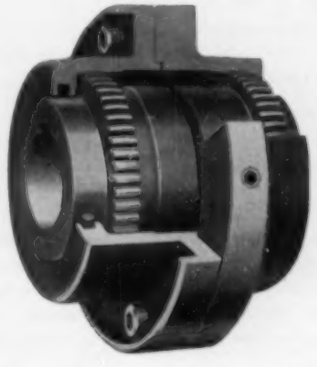
One type of casing for "RC" couplings, Style "R" is made of spun aluminum, is rust proof, and affords complete protection against other objectionable conditions, such as dust and water. Another type, Style "P," is made of plastic. Its horizontal split makes it possible to install or remove the casing while the coupling is in place on the shaft.

Fig. 1—Coupling with style "P" revolving casing.
Fig. 2—Coupling with style "R" revolving casing.

Geared flexible couplings are especially suited for high speed and high torque applications. Although they are light weight, these couplings are sturdy and transmit power efficiently. Because of their design, they can accommodate a reasonable amount of shaft misalignment and end float.

The two-section, free-floating housing has internally cut gear teeth. Its sections are rabbet fitted and are bolted together to function as a single, rigid unit, forming a dust-proof, lubricant-retaining enclosure. The wide face of the internal gear teeth provides for end float of connecting shafts while maintaining full tooth contact. Externally cut gear teeth on the hubs are machined to provide constant clearance at the root of the internal teeth of the housing, thus accommodating reasonable misalignment.

(Below) Cutaway view of Link-Belt geared flexible coupling.



SNOW-NABSTEDT

MARINE AND INDUSTRIAL GEARS

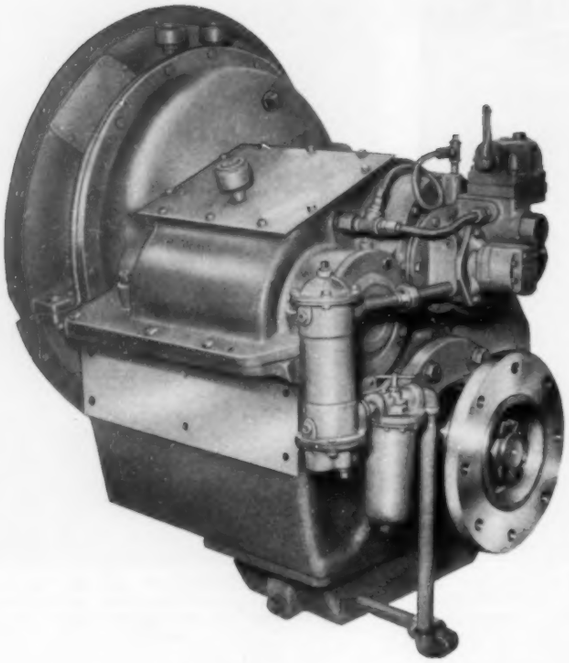


Fig. 1 S-N Series 3900 Reverse-Reduction Gear.

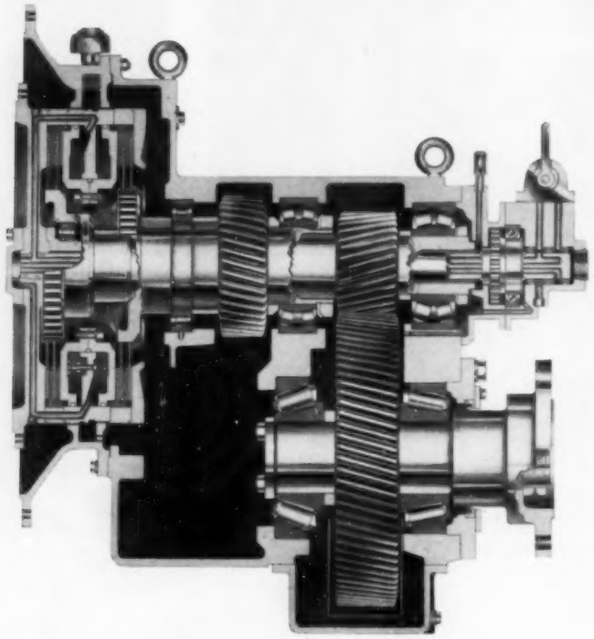


Fig. 2 Cutaway view of S-N Hydraulically actuated Marine Gear.

SERIES 3900 MARINE GEARS—Famous as manufacturers of the original "Joe's Gears," the Snow-Nabstedt Gear Corporation of Hamden, Connecticut has introduced a new line of marine hydraulically actuated reverse-reduction gears designated as S-N 3900. Product of 50 years of experience in this field and over 5 years of intensive engineering and development, the Series 3900 is primarily for the newer, high-speed, more powerful diesel engines. Snow-Nabstedt has distinguished itself as a manufacturer of quality transmission equipment for both marine and industrial applications in horsepower from 40 to 1,000.

First in the new line are two models (3961 and 3971) which are currently in production. Other models are in the engineering and testing stage. Model 3961 has a torque capacity of 1640 ft-lb, and can handle up to 500 HP at 1800 rpm under continuous heavy-duty service. Model 3971, with a torque capacity of 2400 ft-lb, will handle up to 750 HP at 1800 rpm in continuous heavy-duty service. Both models will operate at higher speed, and standard adaptations are available with SAE flywheel housing 0 or 00.

Outstanding features of the new models are: (1) Low price per horsepower. (2) A standard unit for either engine rotation and for either hand propeller. (3) Capacity to operate in either direction at high speed with equal life at full power and full speed. (4) Wider choice of reduction gear ratios (2:1 to 5:1) in two standard housings. (5) Transmission of 100% of engine speed in both directions. (6) All accessories are outside of gear housing for easy servicing or replacement. (7) The output coupling need not be removed to replace split oil seal—a big time saver.

The cutaway of the S-N gear shows the arrangement of the clutches, gearing, bearings and shafts. (See Fig. 2) (Note: The jack-shaft and its gearing have been eliminated to show the construction of the main part of the gear.) The following features are important:

The multiple disc wet clutches are of sintered bronze and steel. They have a high coefficient of friction, cooled and lubricated by low pressure oil circulation.

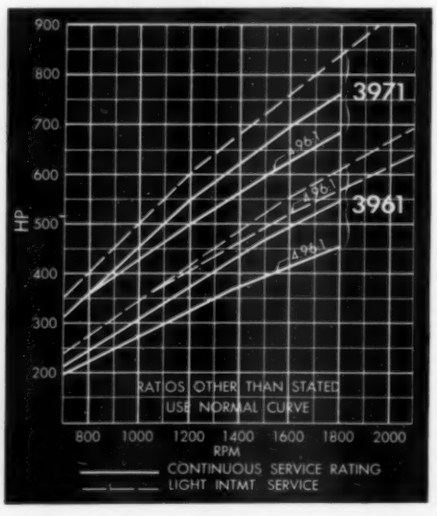
The shafts are of heat treated alloy steel supported rigidly in the housing on anti-friction bearings. The anti-friction heavy-duty bearings are designed for radial and thrust loads. The Timken tapered roller thrust bearings take the ahead and astern thrust.

The helical gearing is carburized, hardened and ground. The bull gear is shaved and induction hardened to insure accuracy in mesh. The lube oil system is separate from the engine system and has a large sump to insure adequate lubrication and cooling.

The maximum continuous and intermittent speeds are shown in the power curves. (See Fig. 3) These power curves show the maximum horsepower that the transmission can transmit at various engine speeds. The broken line indicates the maximum power which can be transmitted on light, intermittent service. The solid line indicates the maximum power that can be transmitted for continuous operation. Service rating curves marked by gear ratio give the ratings only for the specific ratio so marked. For special applications, power curves for the transmission and reduction gear ratios will be supplied upon request.

The schematic diagrams (See Fig. 4 and 5) illustrate the flow of power through the clutches and gearing in either anti-engine or engine rotation. In both diagrams the engine flywheel delivers the power counter-clockwise. If the engine flywheel rotates in a clockwise direction, all the arrows will be reversed.

Fig. 3 3900 Series Power Curves.



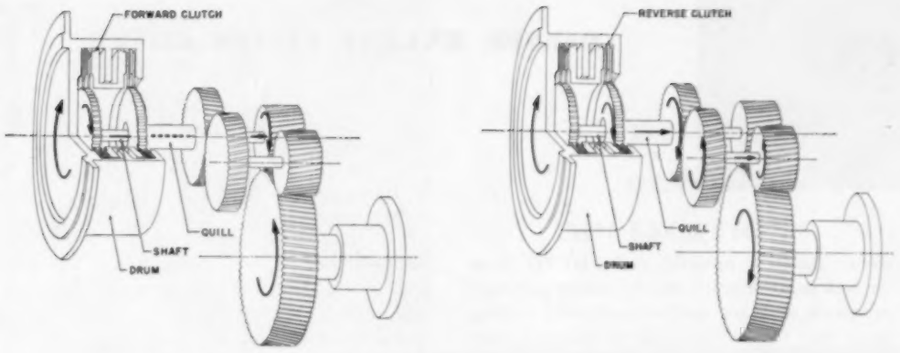


Fig. 4 Power Flow Anti-Engine Rotation

When the *forward clutch* is engaged, the power flows through the discs to the center shaft with its high-speed pinion and thus to the bull gear. The gearing on the jack-shaft rotates with no load.

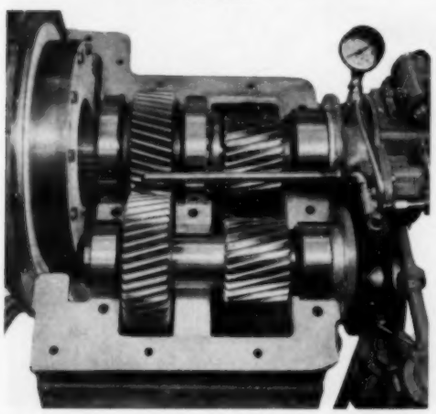
The *reverse clutch*, when engaged, transmits the power through the discs, to the quill shaft, to a gear which is in mesh with the pinion on a parallel jack-shaft. A high-speed pinion on the opposite end of the jack-shaft drives the bull gear. All the gearing is constantly in mesh.

In *neutral* both clutches are disengaged, eliminating all power to the propeller shaft. This assures full engine power for operating auxiliary equipment. The gears are designed to permit indefinite idling without generating abnormally high temperatures.

Hydraulic pressure and lube oil is delivered to the selector valve under a pressure of 125 psi from a positive-displacement type pump. From the selector valve it is led, depending upon lever position, through passages in the pump adapter and the pump drive shaft. It then goes forward to either the forward or reverse clutch cylinder. The opposite cylinder from the directed oil is vented back through the selector valve. Thus the piston frictionally engages either one of the two disc clutches, and twice the clearance in the idling clutch is obtained. These are wet clutches and the annular spaces between them are constantly filled with oil, thus eliminating a time interval required to build up pressure.

Therefore, response is almost instanteous. By-passed oil from the pressure regulating valve goes into the lube oil system. Part of this oil is sprayed over the gearing at approximately 5 to 15 psi. The rest is then led around the pump drive shaft, forward to lubricate bearings and to cool the clutch discs. The oil from the clutch drum is vented to the gear sump. In neutral both cylinders are vented through the selector valve, and all the oil is delivered to the lubricating system.

Fig. 6 Series 3900 with top half of split housing removed.



These gears have been designed for simplicity of servicing. The selector valve, pressure regulating valve, pump and pump drive and the rotary-seal insert may be removed as an assembly for servicing without opening the gear housing. The transmissions have a split housing and adapter, making it possible to remove the clutches and most of the gearing without disturbing the alignment to propeller shaft or engine (Fig. 6).

INDUSTRIAL GEARS—Snow-Nabstedt reduction gears for heavy-duty equipment are designed for use on original equipment or for repowering all types of industrial, farm and construction machinery. They are built to give dependable around-the-clock service on cranes, pumps, shovels, generators, draglines and all types of dredging and ditching equipment.

The reduction gearing is of herringbone design. The gears are made from the finest quality steel, accurately cut, shaved, and hardened. The herringbone design eliminates the usual thrust developed by helical gearing and is quieter and more powerful.

All gearing is straddle-mounted in ball or roller bearings with no overhung design. A double row ball thrust bearing is mounted at the output shaft to counteract any thrust induced by the driven equipment.

A standard power take-off clutch with gear tooth drive is used. To compensate for wear, the clutch may be adjusted by a simple hand operation performed through an access plate on top of the clutch housing.

Gears and bearings are splash lubricated. Bayonet oil gage and oil drain plug are provided so that correct oil level may be maintained. The clutch throw out collar is lubricated through a grease fitting located on the side of the clutch housing.

All shafts are heat treated alloy steel and accurately finished to close tolerances. Output may be had in either stub shaft or flanged coupling. Seven models are available to handle a horsepower range from 40 to 755, and up to 3300 ft-lb of engine torque. Gear ratios from 1:5.1 to 4:1 may be obtained for both anti-engine and engine rotation.

Comprehensive technical literature is available, and inquiries on special applications are invited by the manufacturer.

Fig. 7 Model 2255/3054—250 HP

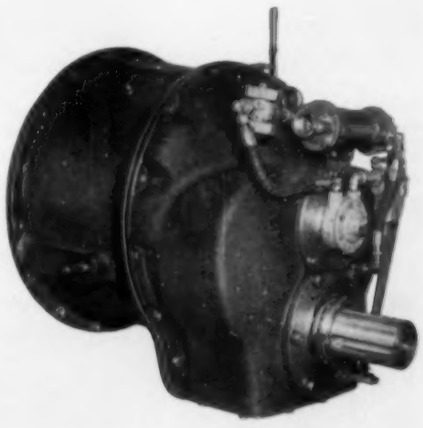


Fig. 8 Model 2275/3175—550 HP

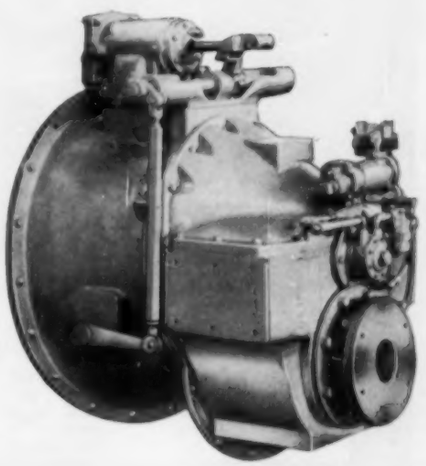


Fig. 9 Model 2285/3085—750 HP

MORSE CHAIN

DIESEL ENGINE CHAIN DRIVE

MORSE Chain Company, a Borg-Warner Industry, has pioneered the use of silent and roller chain drives for efficient, low-cost transmission of Diesel engine power since the evident advantages of chain drives were first demonstrated. Their inherent advantages are flexibility, high efficiency, positive drive connection, durability, low initial cost, easy, inexpensive installation, long service life, simple and quick replacement.

Because of the demand in increasingly more numerous applications for a drive that has the capacity to carry heavy loads at high speeds, Morse Chain Company devoted years of research to the development of the chain drive which transcends the ordinary limitations of most chains; the HY-VO drive.

Some of the greatest successes HY-VO drives have had are in application with Diesel engines.

Many HY-VO drives are on crane conversions where Diesel power replaces steam. Irrigation pumps use HY-VO drives as a connection and speed reduction for Diesel engines. The petroleum industry uses many HY-VO drives on such Diesel powered equipment as draw-works, mud-pumps, compounds, transmissions, etc. HY-VO connects marine Diesels to propeller shafts. HY-VO drives are both being designed into the newest prototype equipment and are used to modernize existing units, with vast improvements in efficiency, compactness, savings in weight and lower operating cost.

Compounding of Diesel engines has a number of advantages over using a single larger engine to obtain the same horsepower. Generally, the cost of two smaller engines and compounding chain drive is less than that of a larger engine with the same total horsepower. In the event of an engine failure or reduced power requirement, single engine operation can be employed.

Because of matchless operating characteristics in the higher speed ranges, HY-VO can be used with small size high-speed Diesel engines with great savings in initial cost.

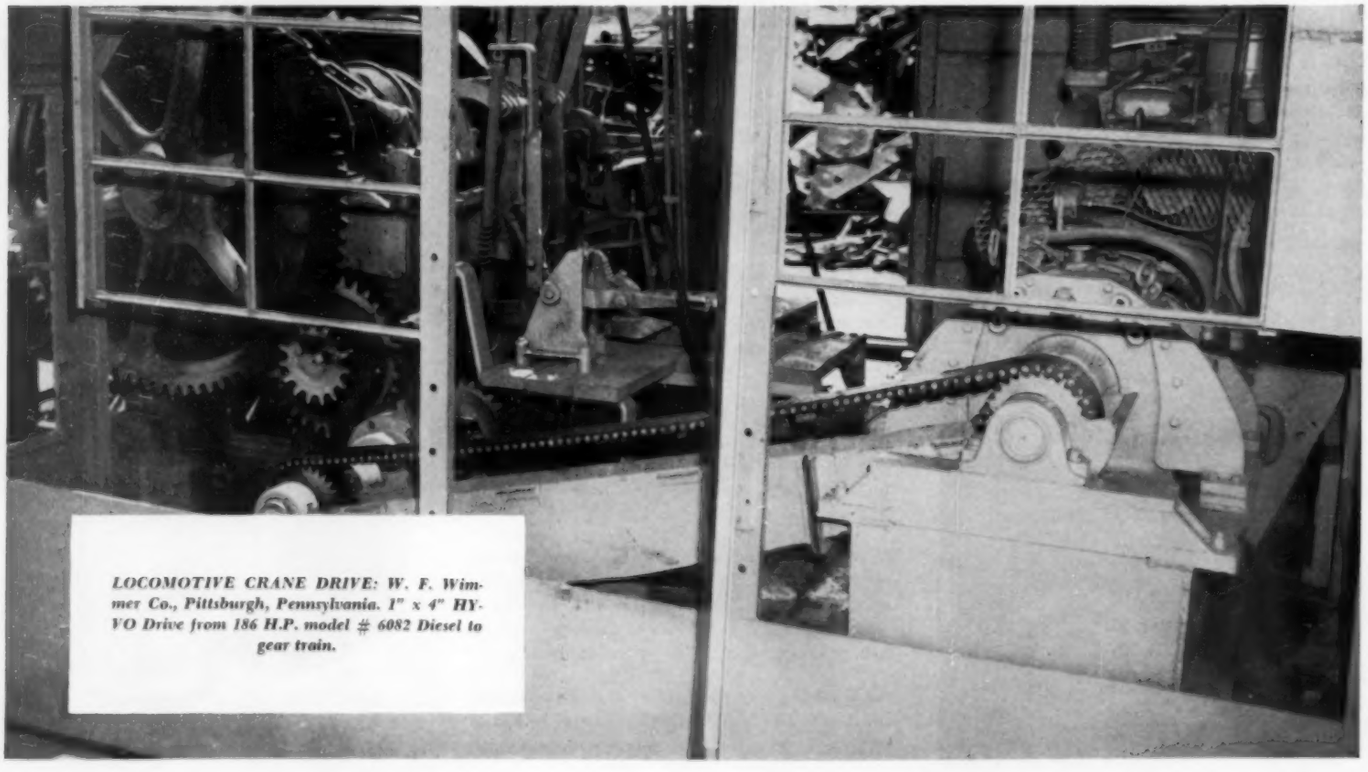
The trend towards smaller, more efficient Diesel engines, which develop greater horsepower through higher rotational speeds, is making it increasingly difficult to compound with gears. As the pitch line velocity of gears increases, their quality must also be better and, as a result, more costly. The ultra-precision placement of bearings to have gears operate at proper spacing and obtain the best rolling condition at the pitch line is necessary.

The Morse HY-VO drive offers features of operation not possible with any other chain, belt or gear drive.

With the smooth operation of a belt and high linear velocities (up to 8500 fpm) the HY-VO drive does not require expensive outboard bearing and shaft extensions, is compact and positive. Its long service life reduces downtime which, in applications such as oil drilling rigs, is extremely expensive.

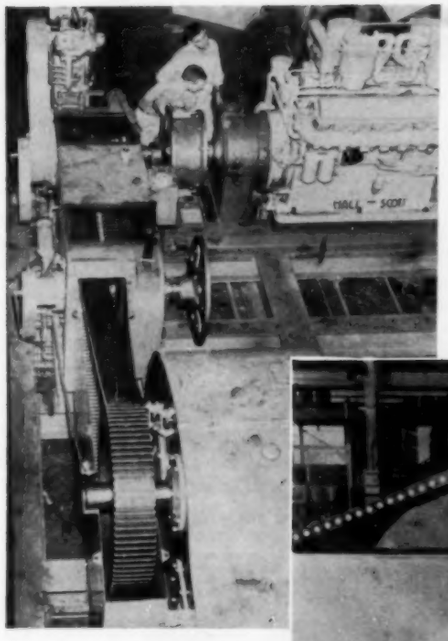
No need for expensive gear trains for long center distances as HY-VO accommodates long or short centers equally well. It delivers more H.P. at higher speeds and with less weight than any other chain drive.

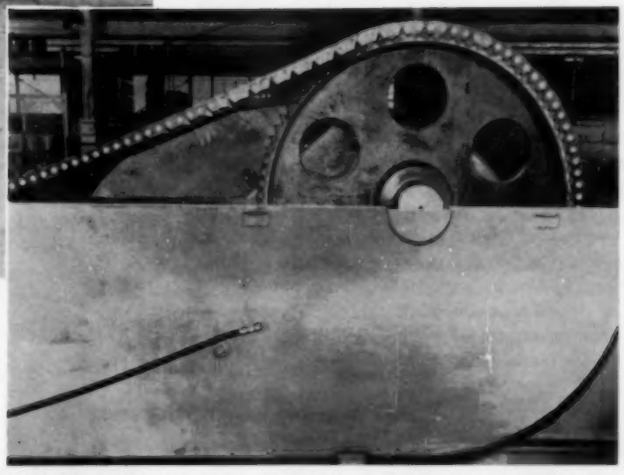
Remember too, that in addition to rugged HY-VO for high-speed, high horsepower applications, Morse Chain manufacturers a complete line of roller and silent chain drives.



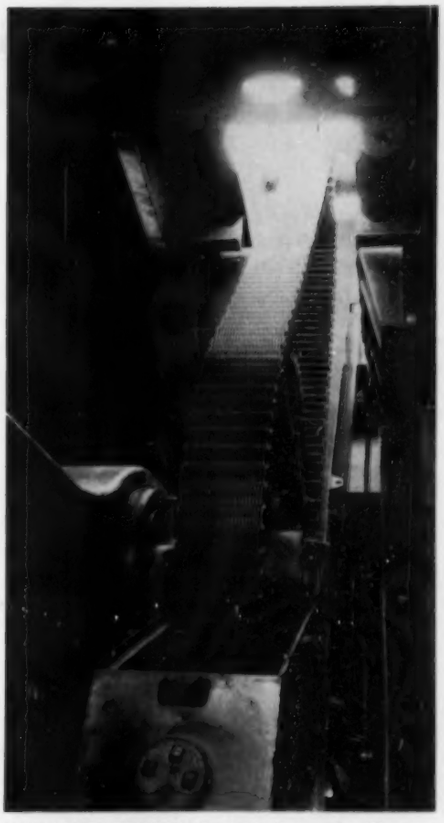
LOCOMOTIVE CRANE DRIVE: W. F. Wimmer Co., Pittsburgh, Pennsylvania. 1" x 4" HY-VO Drive from 186 H.P. model # 6082 Diesel to gear train.

HY-VO DIESEL APPLICATIONS

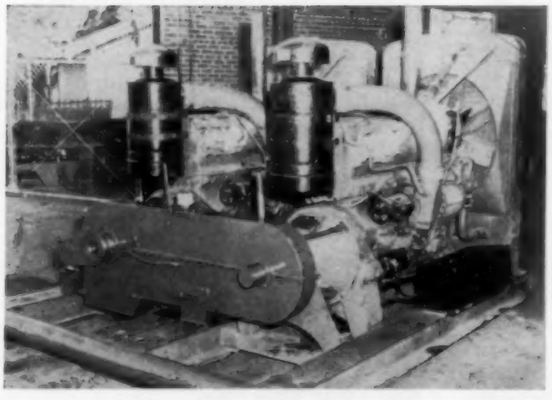




MUD PUMP DRIVE: Fowler Drilling Co., 1½"x4" and 1½"x8" HY-VO Drives compounding 250 H.P. Hall-Scott V-12 Diesels to Emsco D-500 mud pump.



MUD PUMP DRIVES: John W. Mecom Co., Houston, Texas, Drilling Barge, 2" pitch x 8" wide Hy-Vo Drive from two compounded 520 H.P. G.M. Diesels to Emsco D-850 pump. 2" pitch x 6" wide Hy-Vo Drive from compounded G.M. Diesels to Oilwell P-220 pump.

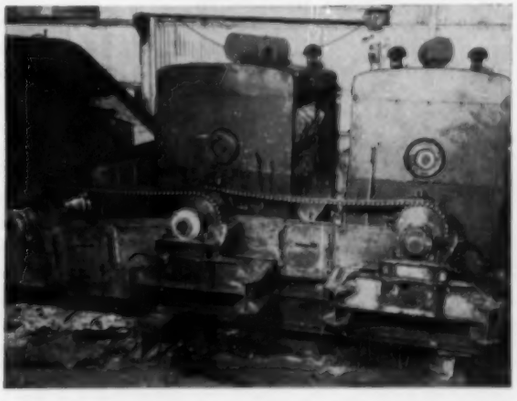


COMPOUNDING WITH HY-VO

Here, a 1" pitch x 3" wide HY-VO is used to compound two 1800 rpm. Cummins Diesels to drive a pump.

COMPOUNDING OIL DRILLing DRAWWORKS

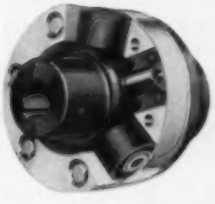
A 1½" pitch x 3" wide HY-VO compounds these two "Cat" D 17000 Diesels rated at 200 hp. A secondary HY-VO Chain 1½" pitch x 6" wide drives the drawworks at 900 rpm and 3600 fpm. Compact, lightweight HY-VO saved so much bulk over conventional drives that the drawworks could now be built as a single unit; easily hauled on one truck.



MORSE FLEXIBLE COUPLINGS

MORFLEX FLEXIBLE COUPLINGS

These torsionally flexible couplings, with a wide range of torque capacities, use the exclusive More preloaded neoprene biscuit assembly designed for uniform stresses and linear deflection. Morflex construction eliminates metal-to-metal contact between driving and driven members, requires no lubrication, is unaffected by oil, dirt, dust, weather.



MORFLEX RADIAL COUPLINGS

Morflex Radial Couplings embody the use of the same exclusive Morse designed, preloaded rubber biscuits which are assembled radially. This radial construction permits the design of couplings having high torque capacities, yet still retaining torsional flexibility. They are used to great advantage on diesel drives subject to heavy torque loads, shock, or high frequency load reversals.

DRC ROLLER CHAIN COUPLINGS

The most rugged and economical of all Morse couplings, Morse DRC Couplings are designed to provide flexible and large capacity applications of moderate speed and steady loads.

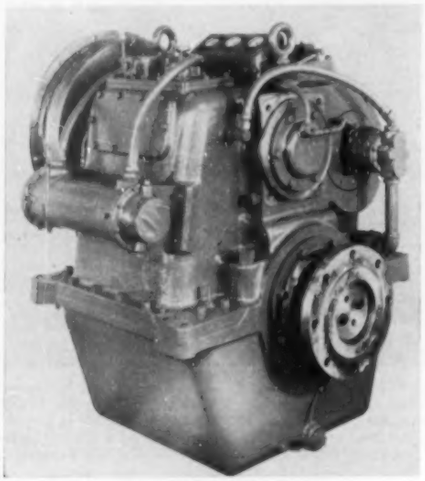
DSC SILENT CHAIN COUPLINGS

Simplest of all Morse Couplings, DSC Silent Chain Couplings provide full surface contact of chain and sprockets, assuring more than just "line contact," and giving an even distribution of load and wear of chain and sprockets.

WESTERN GEAR

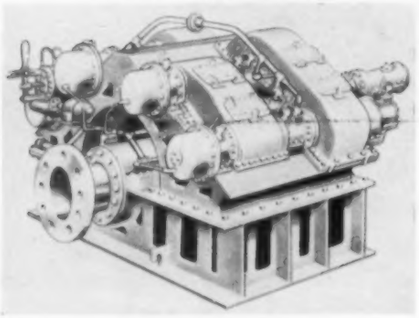
POWER TRANSMISSION EQUIPMENT

FOR more than 65 years Western Gear Corporation has furnished geared power transmission equipment for a wide range of industry requirements. Some of the "custom engineered" products for diesel engine power transmission are shown on these pages. They represent typical standard units to suit a wide variety of applications. In addition Western Gear Corporation designs and builds special or modified units for specific requirements. Western Gear's engineering "can do" is available to solve any power transmission requirement.

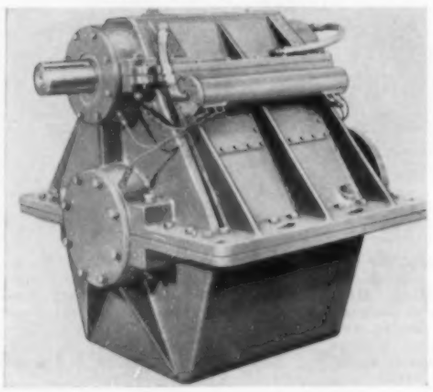


Western Gear Model 180 Sea-Master Reverse and Reduction Gear

Western Gear 6,000 hp Free Piston Gas Turbine Propulsion Gear



Western Gear Sea-Master Model MGV Reduction Gear



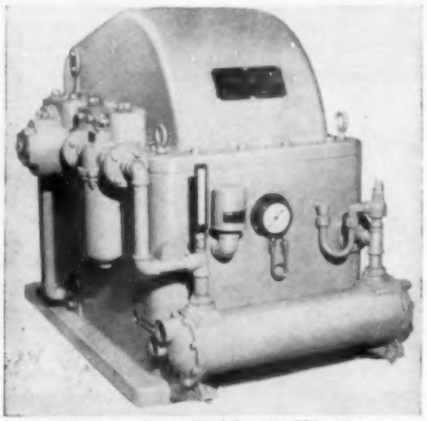
SEA-MASTER MARINE GEARS. Sea-Master marine reduction gears are single pinion units in vertical or horizontal offset type for all types of diesel-powered vessels. Catalog units are available to 5,000 hp and standard types for higher horsepowers in single or multiple pinion arrangements can be furnished. Units have rugged fabricated steel housings, heat treated double helical gearing, anti-friction or sleeve bearings depending on size. All units are equipped with complete lubrication system including positive displacement oil pump to direct oil to all bearings and the gear mesh, oil cooler, filter, and necessary piping. "Owner" features include self-contained oil sump, power take-off drive for auxiliaries, sight gauges for lube oil lines, readily accessible inspection covers, and versatility for all types of installations.

HYDRAULIC REVERSE & REDUCTION GEARS—Sea-Master marine hydraulic reverse and reduction gears are offered in a full line of "custom engineered" models for diesel engine application from 200 to 1200 hp. Most important of the many exclusive features on all Sea-Master hydraulic marine gears is the Western Gear *Flex-Master coupling*. Proven in thousands of hours of the toughest service this highly resilient coupling, plus Western Gear's application techniques, makes any Western Geared propulsion system outstanding in vibration-free operation and trouble-free gear performace. "Wet" hydraulic clutches give smooth shock-free shifts with negligible wear even in the toughest service and no adjustments are required. All bearings, gears, oil pumps, etc., are carefully selected for long life and each application is protected with adequate service factors reflecting Western Gear's long experience in this field. Power take-offs; a choice of manual, pneumatic, hydraulic, or electric clutch control; self-contained hydraulic and lubrication system, including pump, filter, cooler, and temperature and pressure gauges, are but a few of the many exclusive features found in Sea-Master hydraulic marine gears.

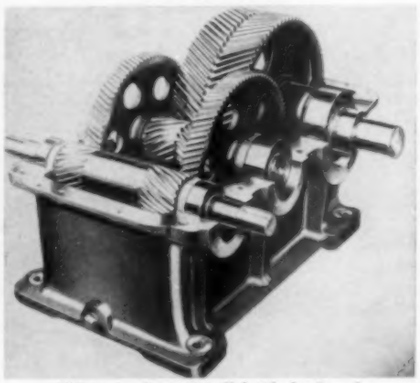
GAS TURBINE & STEAM TURBINE PROPULSION GEARS—Western Gear's long experience in the field of precision high speed gear research, development, and production (see below) includes marine propulsion equipment of the type pictured. Units up to 50,000 hp are available in articulated, nested, or locked train design.

STATIONARY POWER TRANSMISSION UNITS—Western Gear offers a wide variety of products for stationary diesel power transmission requirements—high speed units, parallel shaft and right angle industrial speed reducers, right angle vertical pump drives, Torq-Master transmissions for industrial and oil field applications, and hydraulic torque converters.

WESTERN GEAR HIGH SPEED UNITS— Western Gear offers a complete line of catalog high speed units for driving generators, fans, pumps, compressors, and other similar equipment. Manufactured to Western Gear's high standard of quality and workmanship these units embody features developed over many years of planning, research, and development and proven in years of service in all types of diesel transmission applications. Housings may be of cast or fabricated steel construction of rigid design to effectively control gear alignment. The gearing is of double helical design, heat treated for toughness and long life.

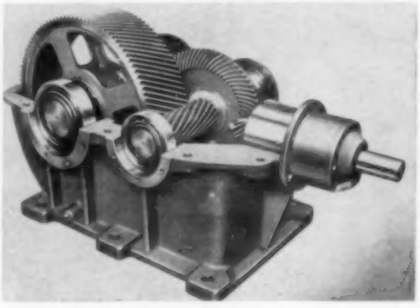


Western Gear Model 250 HS 120 High Speed Unit



Western Gear Parallel Shaft Speed Reducer (Shown with cover removed)

Western Gear Right Angle Spiral Bevel Speed Reducer (Shown with cover removed)



Bearings are of the babbitt lined sleeve type and a complete pressure lubrication system is furnished consisting of pump, cooler, filter, and necessary piping. Each bearing, as well as the gear mesh is cooled and lubricated by an adequate supply of oil delivered by the pressurized lubrication system. All standard Western Gear high speed units incorporate a self-contained oil sump of the required capacity to properly balance the supply of oil with the lubricating and cooling requirements and pump size. A wide range of ratios are available in the standard frame sizes and standard units are supplied to suit the exact speed requirements of prime mover and driven equipment.

INDUSTRIAL SPEED REDUCERS–A full line of standard parallel shaft and right angle speed reducers are available to 10,000 hp to suit all application requirements. Backed by the experience of thousands of applications these units provide an efficient, dependable, and economical answer to a host of everyday power transmission problems.

RIGHT ANGLE PUMP DRIVES–Western Gear right angle pump drives are proven in many thousands of hours of operation. Available in a wide range of sizes from 200 to 3,000 hp these units incorporate precision spiral bevel gear sets, rugged housings, and anti-friction journal and thrust bearings selected for maximum life.

TORQ-MASTER TRANSMISSIONS–Various models of Western Gear Torq-Master transmissions are offered for different power transmission requirements.

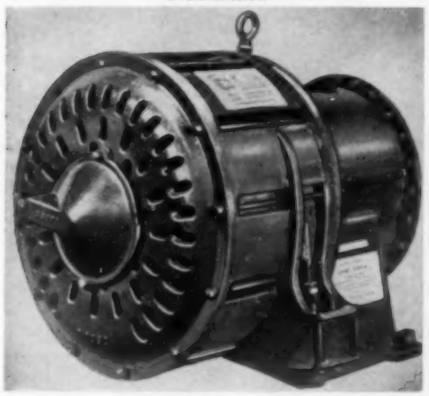
Torq-Master TSD Series–The TSD series units were designed for use with leading commercial hydraulic torque converters. Suitable for yarding or hoisting, this unit has two speeds; direct or 2.33 reduction and may be shifted under full power by air actuated clutches. Hundreds of Torq-Master TSD's are in service in the rugged logging areas of the Pacific slope and on various hoisting applications. Torq-Master TSD's are designed to transmit up to 600 HP from single stage torque converters.

The Torq-Master 200 series transmission incorporates a Western Gear torque converter (Schneider System) and a bevel planetary two-speed transmission into a single compact power package for use with diesel engines up to 300 hp at 2100 rpm. The Torq-Master "200" also has fixed ratio gearing incorporated into the unit to facilitate its adaption to existing or new machinery where increasing overall ratio to insure optimum torque converter performance is difficult or costly. The Torq-Master "200" is also available in a reversing model for applications in locomotives, locomotive cranes, and other machinery where a quick shift full power reversing unit is required.

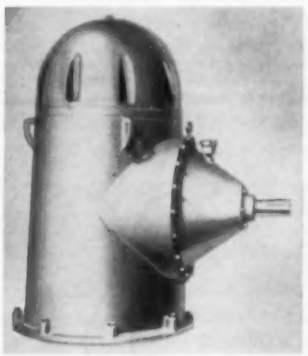
The Torq-Master TSO series transmissions were especially designed to meet the requirements of separate engine driven oil well rotaries equipped with torque converters. Ruggedly designed and built, these two-speed reversing transmissions have been operating for many years on leading makes of rotary table equipment. Units are available up to 850 hp.

Hydraulic Torque Converters–Western Gear hydraulic torque converters (Schneider System) are available in a complete range of sizes and types to suit engines of from 150 to 600 hp at 2100 rpm. Optional output arrangements are available to suit Torq-Master TSD, chain housing, direct drive, Fuller-Spicer transmission adaptions, crawler tractor conversions, and many others.

Western Gear Torq-Master TSD Transmission



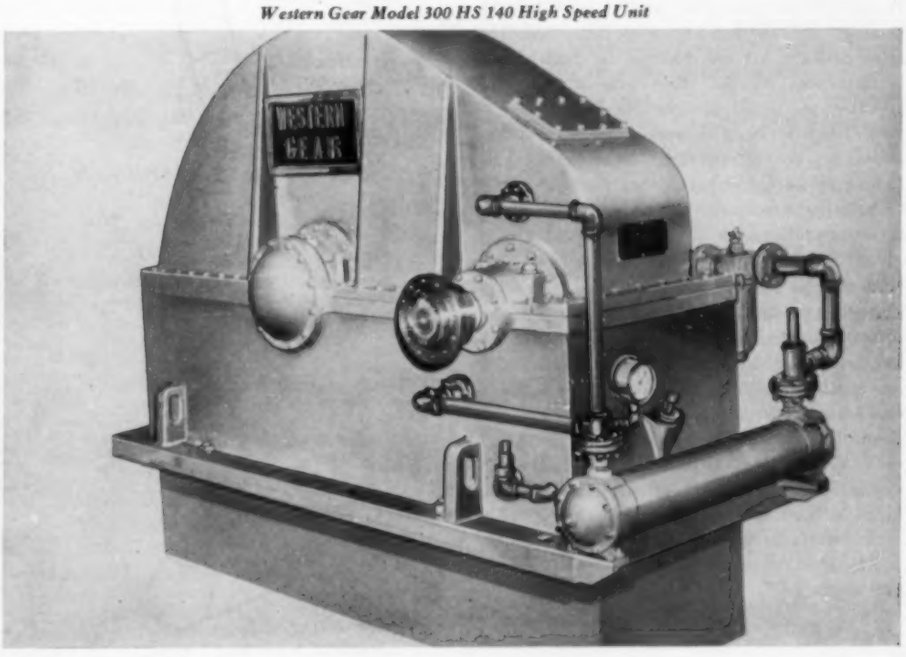
Western Gear Right Angle Pump Drive



Western Gear Torq-Master TSO-245 RHD

Western Gear Torque Converter

Western Gear Model 300 HS 140 High Speed Unit



DIAMOND

DIESEL ROLLER CHAIN DRIVES

ROLLER chains and gears are the two most accepted media for driving diesel engine components such as camshafts, fuel injection pumps, blowers, water and lubricating oil pumps and generators, and designers confronted with the problem of drive selections in an engine development, usually consider all chain layouts, all gear layouts, and combination chain-gear layouts, making final selections from these three, of the layout best suited to the engine in development.

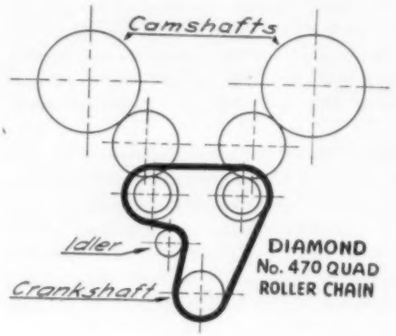
Diamond's experience in applying roller chain to engine drives, alone or in combination with gears, goes back more than a quarter of a century and this experience is available to engine designers, the majority of whom regularly draw on it when designing a new engine or redesigning an earlier model.

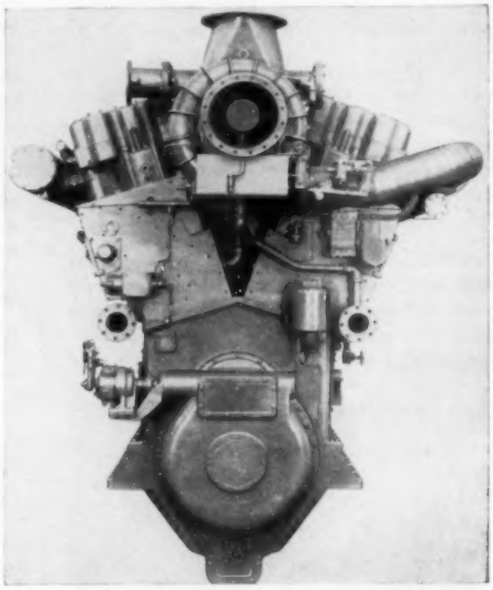
Roller chain drives are relatively low in first cost and in cost of installation. Adjustable idler sprockets can be used to compensate for the extremely slow rate of chain wear or where advantageous, two sprocket, fixed center drives may be used to greatly simplify design by avoidance of extra shafts and bearings. Chain drives readily accommodate initial variations in shaft center distance, thus reducing the cost of machining engine frames and also saving time and money in erection floor, drive fitting.

Sprockets are less costly than equivalent gears; camshaft sprockets are made of Meehanite iron and machining tolerances need not be so close as for successfully running gears. When center distances are long, roller chain drives simplify the mechanism and save weight and cost by elimination of intermediate gears with their shafts and bearings, and the lubrication of them. Sprocket tooth pressures are low, because the driving load is distributed by the chain over many teeth. Sprockets are usually designed to outlast the engine. Tooth breakage in normal operation is unknown, but even if teeth should be broken through fouling by foreign objects, drives would continue to function satisfactorily by action of the chain on the remaining teeth.

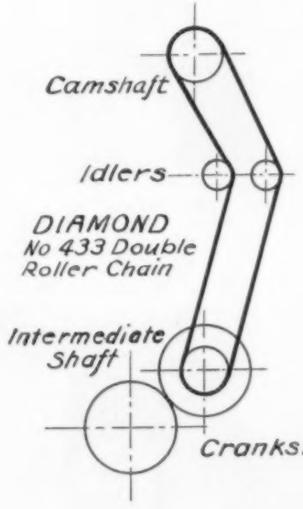
Roller chains have such a great excess of tensile strength beyond that required to transmit the power load, that breakage can occur only if the auxiliary being driven becomes locked, in which case chain breakage is protective to other machine elements. Under these circumstances, the chain is thrown clear of the sprockets, and the drive can be quickly restored to its original efficiency and dependability by the installation of a new chain on the original sprockets. Thus roller chain drives meet every test for reliability and dependability which are so important in every sort of Diesel engine operation.

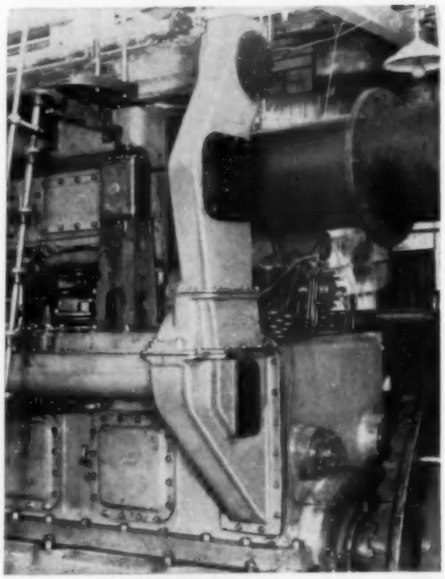
Roller chain drive life in a given case is predictable, and any replacements needed can be made during planned overhauls. It is usual to select roller chain drives with sufficient reserve capacity to last the life of the engine; but if light weight and compactness are paramount, they can be selected for a shorter life and regarded as replaceable service parts. New chains can be installed on the original sprockets as needed, during scheduled





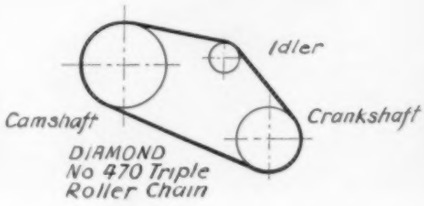
Cooper-Bessemer L.S.U. 3700 H.P. Supercharged 4 cycle diesel. Primary drive is Diamond 1¼" pitch quadruple strand roller chain. Secondary drives are gears.

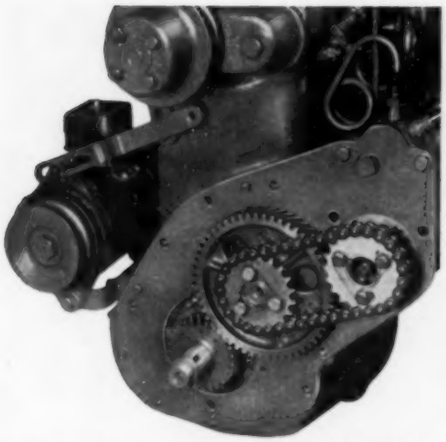




Chicago-Pneumatic Tool Co.—4 cycle Model 862 Diesel Timing drive Diamond 1¼" pitch roller chain.

Fairbanks, Morse, 2 cycle model ARI diesel Primary drive is gearing. Secondary drive is Diamond ¾" pitch double strand roller chain.





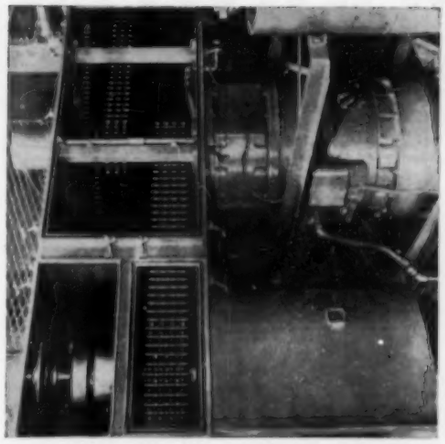
Buda Co. Model 6BD-230 6-cylinder Camshaft drive gears. Injection Fuel Pump drive Diamond ½" pitch single strand roller chain.

engine overhaul operations. Engines need never be out of service because of chain drives. Although sometimes heavy loads, high speeds and crankshaft torsionals create severe drive conditions, roller chain drives can take them when properly selected originally. They have inherent advantages which make them particularly suitable for Diesel engine auxiliary drive installations. They are initially quiet and remain so throughout their service lives. Roller chains create no end thrusts, separating forces, nor similar problems. Paralleling their usage inside of the Diesel engine, Diamond roller chains are essentially for external engine drives which transmit full engine power through a wide range of speed and ratios.

The oil industry needs rugged transmissions to withstand the severity of drilling rig service and the high torque variation that characterizes well-pumping units. Diamond roller chains were adopted long ago for these uses on account of their dependability and economy. Roller chains are widely used in multi-speed transmissions and for compounding the power of two, three, and four engines, especially on rigs with Diesel engines. The trend toward hydraulic controls on tractors, industrial trucks and earth moving vehicles, has created a need for yet another external engine drive, to the hydraulic pump supplying the control fluid.

Usually the drive can best be taken off the free-end of the crankshaft and the first drives were belts. However, belt slippages and resultant loss of control at critical operational moments, turned designers to positive drives. Gears were tried with success in some instances but the simplicity and quiet operation of equally positive roller chains has caused designers to turn to them for this vital drive.

Diamond couplings utilize the advantages of flexibility and easy detachability of roller chains, and consist of two single strand sprocket halves, each mounted on one of the two shafts to be coupled and wrapped by a double strand roller chain with each sprocket half meshing with one strand of the duplex chain. The chain is connected endless with a single pin. This coupling, which accepts axial and non-parallel misalignment of coupled shafts,



Rear section view of Wilson Giant Torcair oil well drilling rig with Diamond multiple strand roller chains compounding power from engines to drawworks.

is particularly suitable for coupling generators and water pumps from the auxiliary drive take-off stub shafts of internal combustion engines. It is extensively used for this purpose because it compensates for the condition of misalignment, which always tends to exist to some degree, without exerting any shaft alignment forces except in extreme and abnormal circumstances.

Diamond couplings are available in a complete range of stock sizes, and are made-to-order for special applications. They are supplied with cast aluminum or spun metal casings when housings are required.

ROTARY-POSITIVE DISPLACEMENT

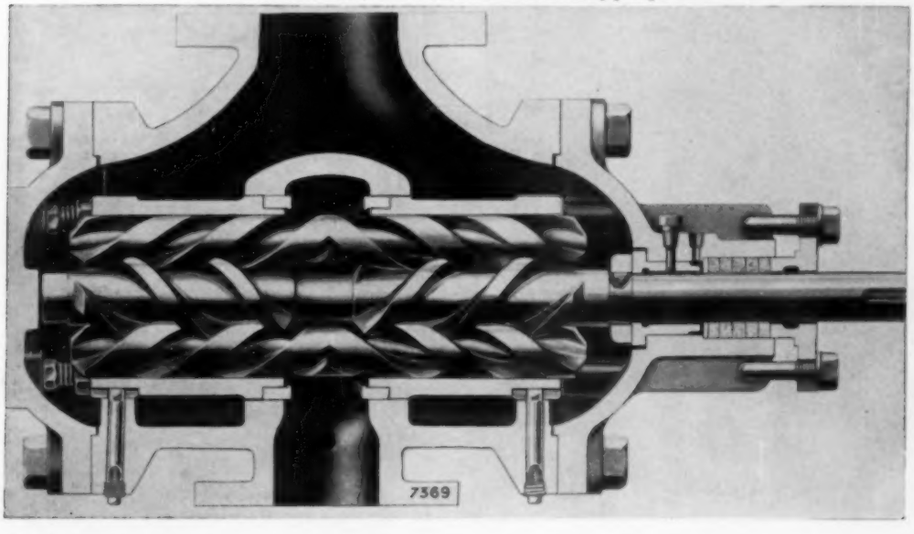
DE LAVAL-IMO PUMPS

THE De Laval IMO is a constant-displacement, rotary, screw-type pump. The illustration shows the basic elements of the IMO design—three screws with threaded surfaces shaped so they form a tight seal relative to each other and to the surrounding housing or cylinder. As the screws rotate, closures are formed sealed from each other by the threads. These closures transform rotational motion into continuous and uniform axial motion.

Thorough pioneer mathematical analysis led to the design of the IMO screws. This resulted in (1) the theoretical principle for complete sealing; (2) the determination of kinematically correct thread proportions; (2) the selection of the correct number of threads and screws.

In the standardized construction of the IMO design, there are three fully meshing screws—one power screw (rotor) and two idler screws (rotors) placed symmetrically. Proportions of the three double-threaded screws allow a one-to-one ratio between the rotors so that the idler rotors roll on the power rotor. The mathematical analysis of screw thread proportions proved that fluid pressure could be used to drive the idler or sealing rotors. Thus, the entire work is delivered or absorbed by the power rotor. The idlers, which rotate in the opposite direction, serve merely as sealing elements. Consequently, in the unique IMO design, the screws need not be connected by power or timing gears.

Cross section of Imo center intake and delivery pump.



The threads of the IMO screws are shaped so that the volume enclosed by the threads remains constant during the entire pumping cycle. There are no tooth or end clearance volumes to pocket the liquid pumped. Thus, no destructive hydraulic compression forces or fluid shock occurs between the threads; no internal leakage canals are needed to relieve such forces and diminish capacity.

The IMO is exceptionally quiet in operation because of the natural, smooth rolling action of the cooperating screws, elimination of timing gears and absence of hydraulic hammer. Due to the theoretical correctness of the design and arrangement of the IMO screws, the velocity of the liquid being pumped is inherently low. Thus even at direct-connected motor or turbine speeds, De Laval-IMO pumps operate at high efficiencies.

SCHWITZER CORPORATION

NEW LINE OF TURBOCHARGERS

With an accumulated ground usage of many million of miles, Schwitzer Corporation announces production of a new advanced design of turbochargers. These new models incorporate many new engineering features as a result of this vast experience gained through a wide variety of installations now rolling up thousands of additional miles and hours of operation each day. Installations are in trucks, buses, tractors, marine applications, earth moving equipment, including highway and off highway installations as well as stationary engine applications of all type.

Greater efficiencies are now offered in the design of this new series of air cooled turbo units which combine the characteristics of flexibility, light weight, and compactness with new increased capacities per unit size and higher pressure ratios. The increased flexibility of air cooling now permits the use of Schwitzer's turbochargers with both water cooled and air cooled engines. All water connections are eliminated and only two oil connections with the engine are required for lubrication and cooling of the bearing and shaft assembly. These units are capable of operation at pressure ratios up to 3.0 to 1. The new turbos are available in a series of eleven models designed around three basic wheel diameters, three-inch, four-inch, and six-inch. This permits greater interchangeability of common parts and reduces both production and servicing costs.

The overlapping flow ranges, as illustrated on the accompanying chart, permits the customer to use near maximum compressor efficiency on a greater range of engine sizes. These are in addition to the five-inch and six-inch water cooled designs which will continue to be popular on many applications such as in marine use. The enclosed area of the curve for each model is from 95% to 100% of maximum compressor efficiency. The overlapping areas permit matching of any engine within the flow range to within 2% of maximum efficiency.

The light weight of Schwitzer turbochargers and the compact size permits simplified mounting, usually directly on the exhaust manifold, within existing space limitations. The turbine and compressor inlet and outlet flanges may be varied to any one of several angular positions enabling the customer to mount the unit in the most compact manner. Unlike mechanically driven superchargers, no costly gear trains, couplings and special mountings are required with these turbochargers. The cost, therefore, will usually be less than the mechanically driven type.

The weights and air capacities are as follows:

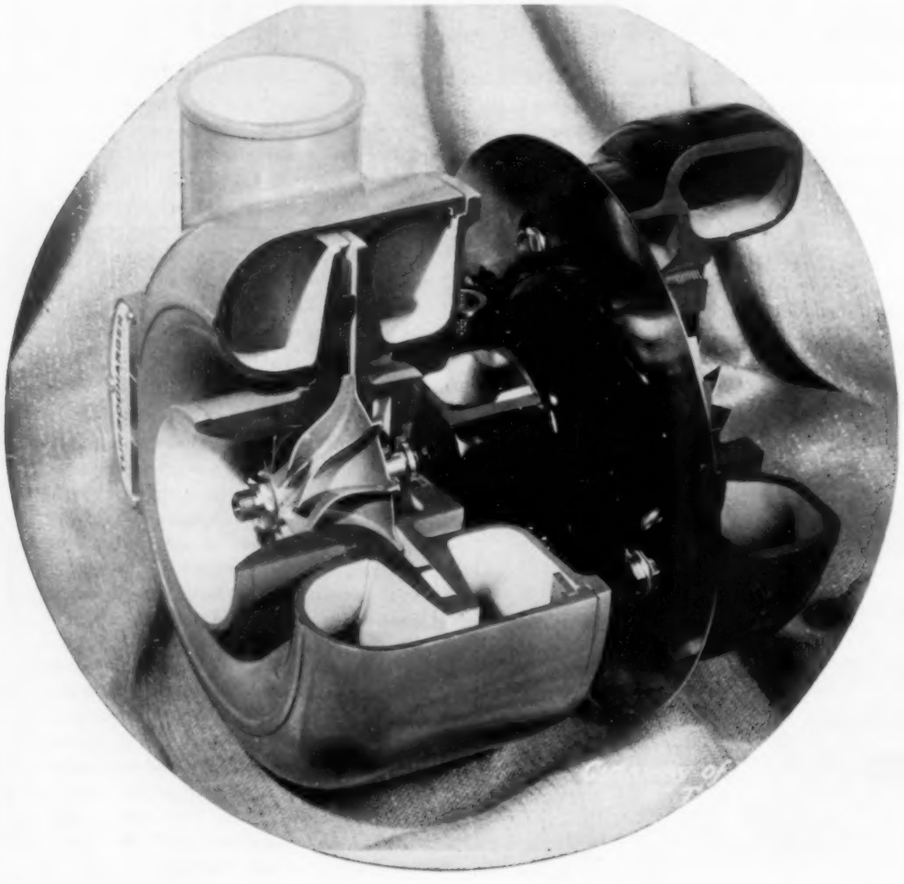
Turbine Wheel Size	Approximate Air Delivery	Weight
3.0 in.	150- 350 cfm	26 lbs
4 in.	325- 850 cfm	36 lbs
6 in.	800-1400 cfm	75 lbs

The above airflows are air flows at a pressure ratio of 2.0 to 1 and are measured at compressor inlet.

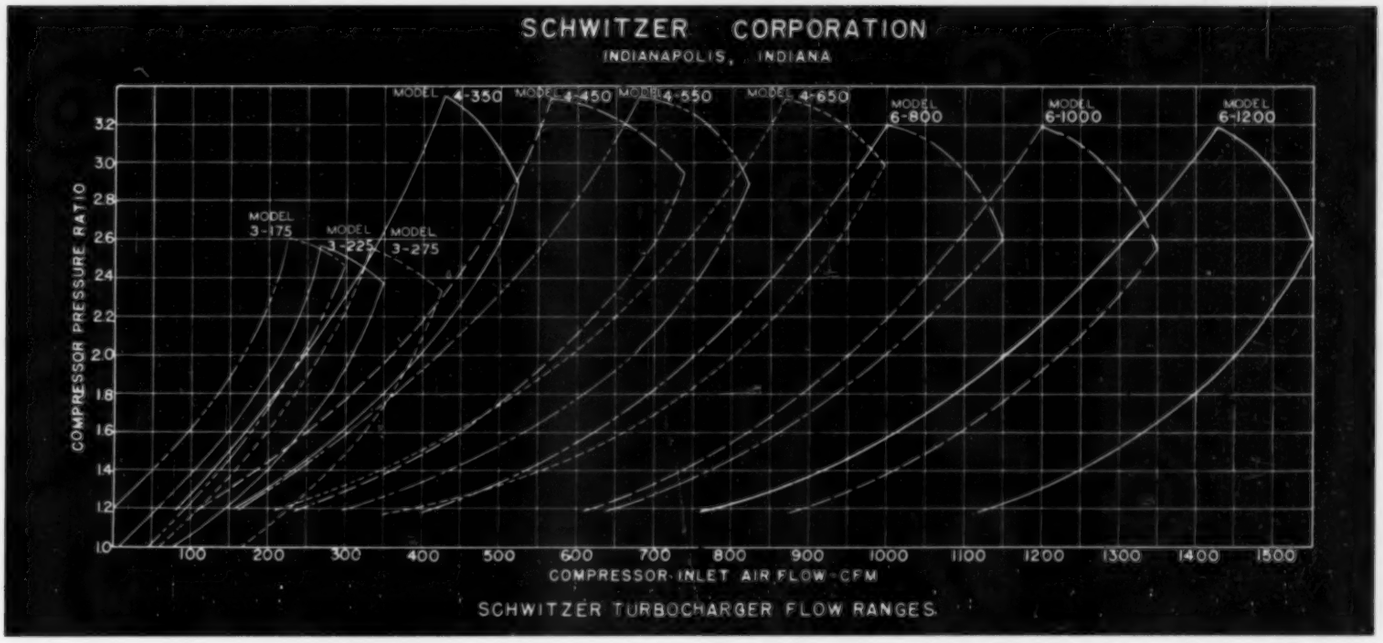
The Schwitzer turbocharger can be adapted to a wide variety of engines without change in basic design. Interchangeable turbine nozzle rings are available to match the operating conditions of each specific engine application. The divided turbine housings and nozzles are designed so that the turbine can be operated either as a blow down turbine or as a steady flow turbine. Ordinarily, better results can be obtained by operating on the blow down principle. This involves dividing the exhaust manifold so that there is no overlap of the exhaust processes of the cylinders discharging into any one branch of the manifold. The divided manifold and turbine housing will make better use of the exhaust gas energy. Lower average exhaust manifold pressures and better cylinder scavenging will result.

Increased efficiencies have been developed and turbine operating speeds have been increased beyond those believed practical only a short time ago. Also, significant results are being obtained with the use of after coolers which reduce the temperature of air leaving the turbocharger and permit increased performance over a wider range. The use of the after cooler is encouraged wherever possible.

Cutaway view of the new Schwitzer 4 in. air-cooled turbocharger.



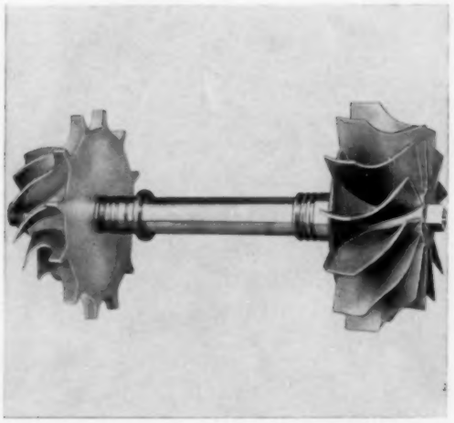
The Schwitzer 4 in. turbocharger shown here, features a clean, compact exterior design.



The turbine housing is a Ni-Resist casting capable of withstanding high temperatures without scaling or stress failures. The bearing housing is a high quality grey cast iron and the compressor housing and cover are heat treated aluminum alloy castings.

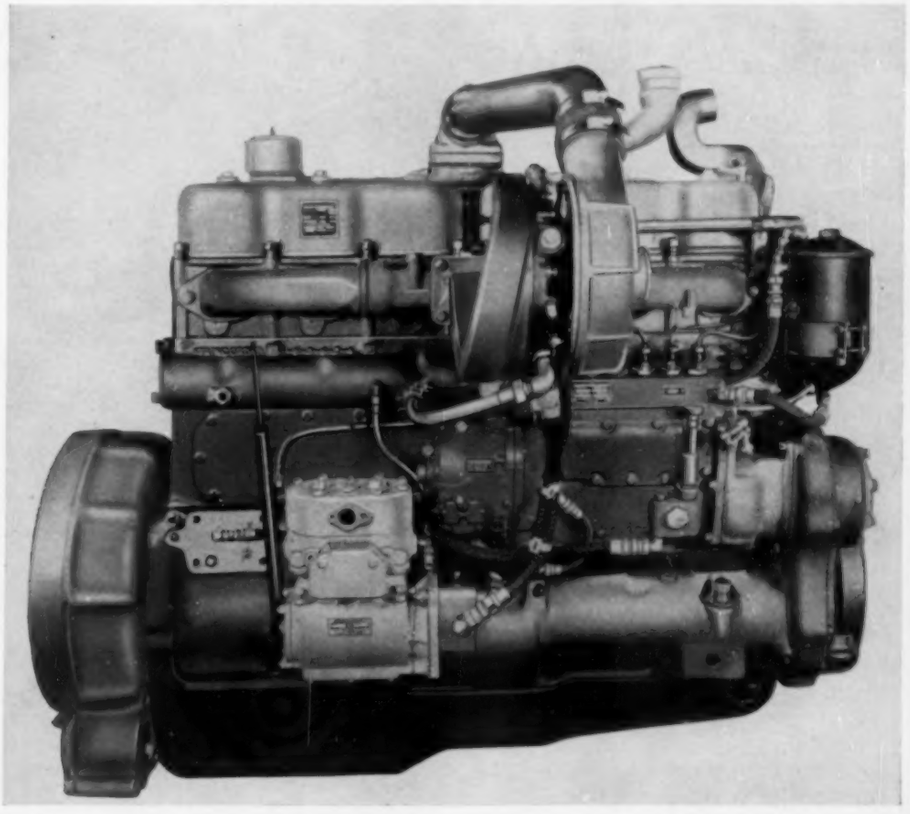
The present recommended exhaust gas temperature limit is 1500° F for intermittent operation. The bearings are of the sleeve type and are lubricated by engine oil. A double piston ring type oil seal is used at each end of the shaft. It is pressurized by an air bleed from the compressor to effectively seal off leakage. Axial shaft location is fixed at the compressor end. The compressor and turbine wheels are designed for thrust equilibrium so that the thrusts between them is balanced out.

The design configuration of the cobalt base alloy turbine wheel combined with aluminum compressor wheel, result in low inertia and low stress. Only a fraction of a second is required for the turbo to reach full speed when the load is suddenly applied to the engine. On variable speed engines such as trucks or buses, this is of prime importance to the vehicle operator. Schwitzer turbos are used on many popular truck, bus and tractor diesel and gasoline engines, and stationary engine equipment as well. They are designed for long, reliable service, and require only normal maintenance afforded other parts of the engine.



Compressor wheel, shaft and turbine wheel assembly of Schwitzer "Orbit Seeking, Instant Action" wheels.

Typical installation of a Schwitzer turbocharger. This is a Mack Thermodyne Diesel rated at 205 hp.



MIEHLE-DEXTER

TURBOCHARGERS

THE rapid progress made in turbocharging large and medium-size Diesel engines, which culminated in the advent of high-pressure turbocharging, has led to a demand for high-pressure turbochargers suitable for automotive-type engines. To satisfy this need Miehle-Dexter turned to the De Laval Steam Turbine Company for a successful, proven design, and now announces a line of small, high-pressure turbochargers for engines ranging in power output from 50 to 1000 horsepower. These units have been developed under a license agreement with De Laval, and their design incorporates the many unique and now service-demonstrated advantages of the De Laval high-pressure turbochargers. They are now being tested by manufacturers of both two- and four-cycle automotive-type engines, for service in road and off-highway vehicles, stationary and marine power plants, etc.

CONSTRUCTION—In common with the De Laval turbochargers, the Miehle-Dexter units are of Monorotor construction—that is, the compressor impeller and the turbine wheel are combined in a single rotor structure, the aerodynamically highly refined compressor blading being carried on one side of the rotor hub and the centripetal turbine blading on the opposite side, as illustrated by Figure 1. The complete rotor is a single precision casting made from a special super-strength high-temperature alloy, which permits great accuracy in manufacture and the attainment of the precise blade shapes needed for this high-performance turbocharger.

The Monorotor type of construction eliminates the windage and leakage losses encountered with the conventional turbocharger construction embody-

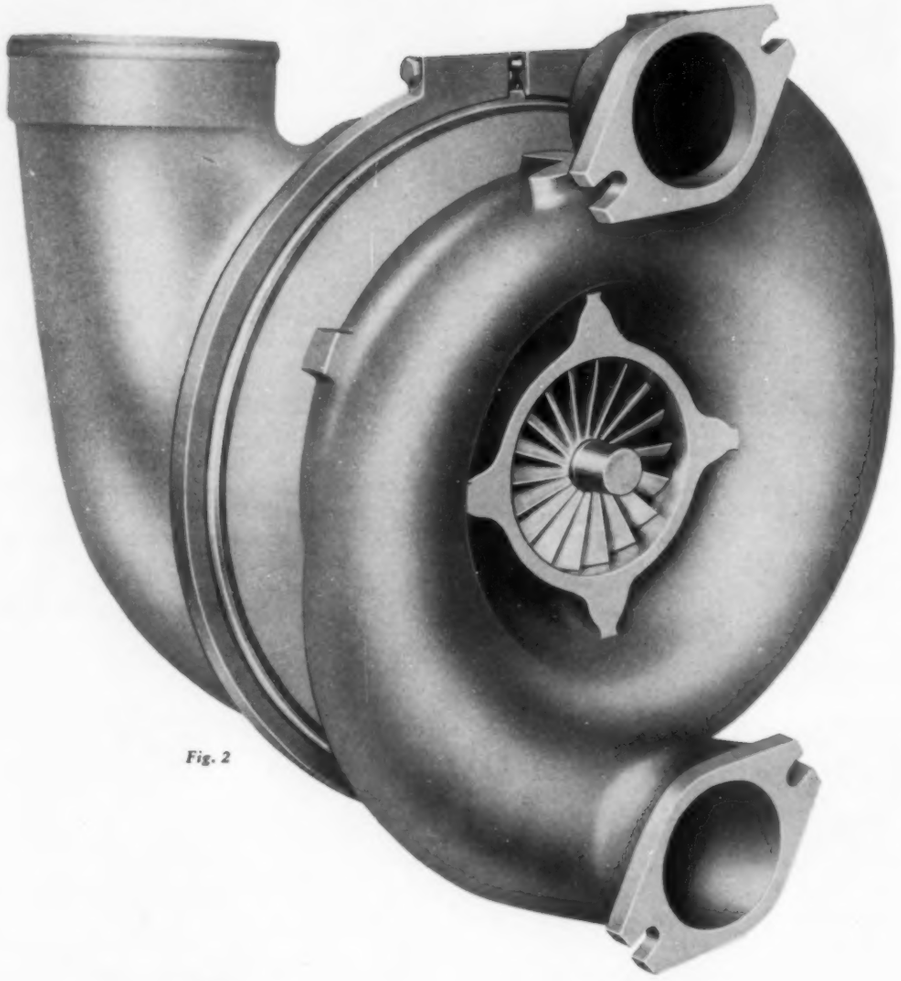


Fig. 2

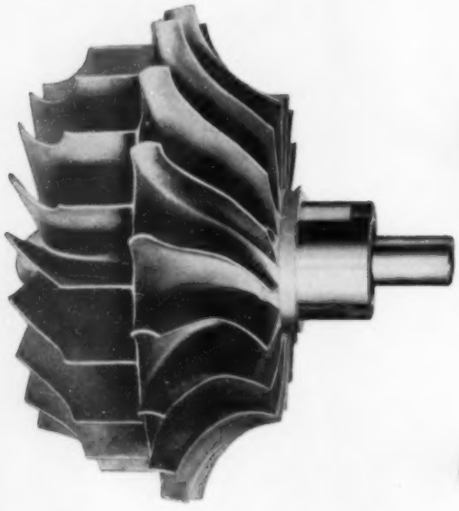


Fig. 1. Monorotor construction.

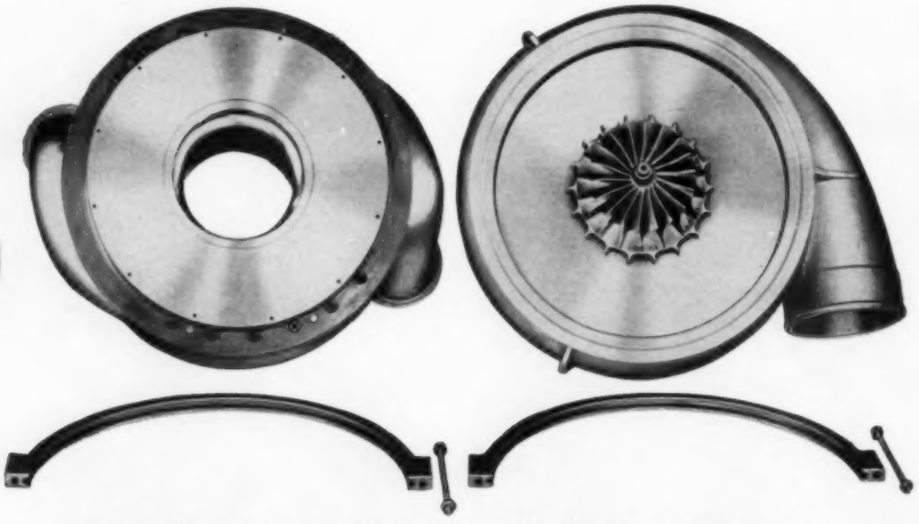


Fig. 3. Turbine nozzle box is shown at left, compressor housing, with rotor installed, at right. Below are clamps that hold these assemblies together.

ing separate turbine and compressor rotors, and thereby contributes to the high efficiency of the Miehle-Dexter units. In addition thereto, this type of construction permits cooling of the turbine side of the rotor in a very simple manner—a small quantity of the air handled by the compressor impeller being by-passed into the turbine, where it is directed (in the form of a thin sheet) over the turbine rotor hub, blanketing it from the heat of the gases.

Another unique construction feature of the Miehle-Dexter turbocharger is its specially-developed high speed rotor bearings, the flexible mounting thereof, and the method of lubrication. This new development in rotor mounting results in exceptional bearing reliability and long bearing life, even under conditions of accidental rotor unbalance (which can occur in service), severe engine vibration or shock loadings encountered by the engine-turbocharger combination.

This new turbocharger is air cooled independent of the engine. No water jacketing of any kind is used—a fact that contributes to the compactness and light weight of the unit and eliminates the need for piping connections to and from the engine cooling system.

While the turbine wheel operates with full admission and steady flow, and therefore with maximum possible efficiency, provisions have been made for the recovery of the energy in the engine exhaust pulsations. These provisions amount, essentially, to incorporation of the De Laval pulse converter system into the turbine nozzle box.

MOUNTING—Because the Miehle-Dexter turbocharger is extremely compact (as indicated by Figures 2, 3, and 4), unusually light, and can be mounted either vertically, horizontally, or in any angular position, it is extremely easy to mount on the engine in such a manner that a clean and neat installation is achieved. This objective is greatly facilitated by the versatility of the unit, which permits rotating the compressor housing vs. the turbine nozzle box into any angular relationship desired.

TURBOCHARGER PERFORMANCE – Experience in the large engine field has demonstrated the astonishing effect of turbocharger compressor efficiency, turbine efficiency and pressure ratio on the engine output, fuel consumption and thermal loading. The Miehle-Dexter turbocharger is now setting new standards for the automotive-engine field with regard to these all-important turbocharger characteristics. The high pressure ratios of up to 3 to 1 and the high performance of the Miehle-Dexter turbocharger permits doubling (and in some cases as much as tripling) the engine output, while at the same time reducing the engine fuel consumption.

Any turbocharger, because mechanically it is independent of the engine, is self-regulating; however, to achieve instantaneous response to engine load changes the extremely light weight, the low inertia of the rotor, and the high turbine torque characteristic of the Miehle-Dexter turbocharger are needed.

MODELS—The new Miehle-Dexter turbocharger will be available in four standardized models, to suit a very wide range of engine sizes. Refer to flow range chart Fig. 5. Approximate dimensions for the various models are shown in the table below, referring to Fig. 4. Weights of the four units vary, from approximately twenty pounds, for the smallest size, to seventy-five pounds for the largest.

	MODEL DESIGNATION			
	3	4	5.5	7
A –	6½"	8"	10"	14"
B –	8½"	11½"	14"	18½"

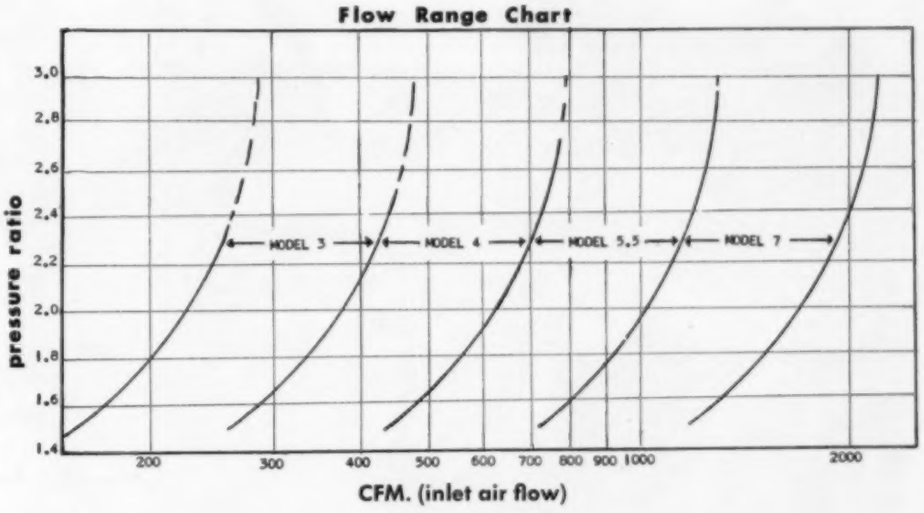


Fig. 5.

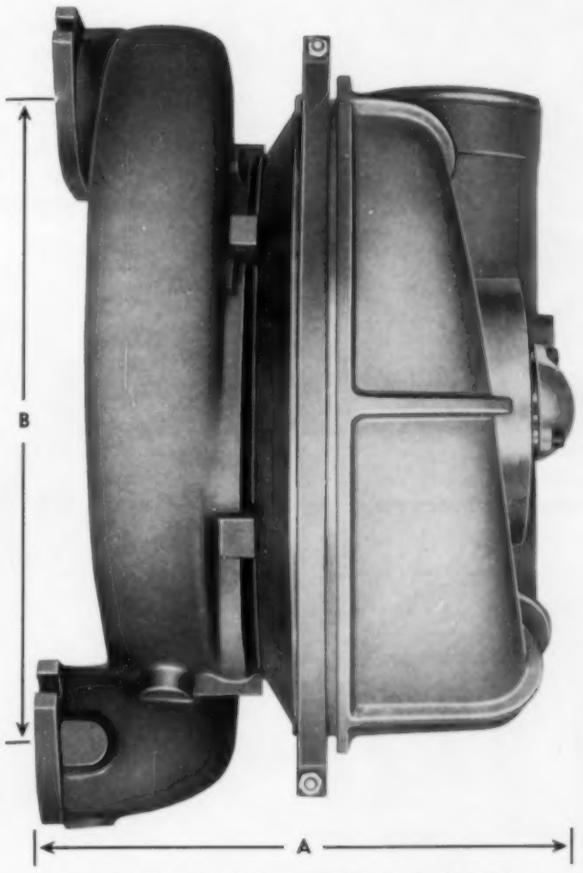
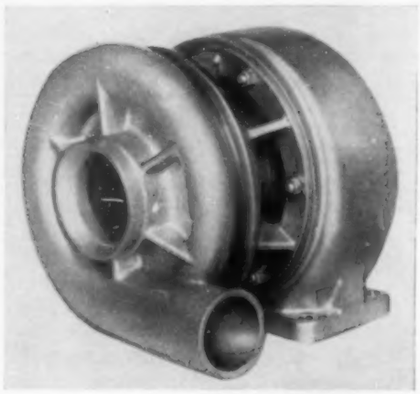


Fig. 4. Side view of turbocharger. Referred to in the article.

GARRETT
AiResearch Industrial Division

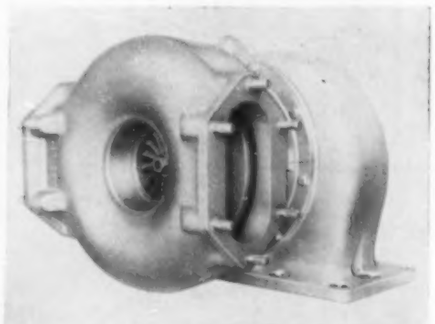
TURBOCHARGERS FOR DIESELS
by
THE GARRETT CORPORATION'S AiRESEARCH INDUSTRIAL DIVISION

AiResearch Turbocharger Model G-27

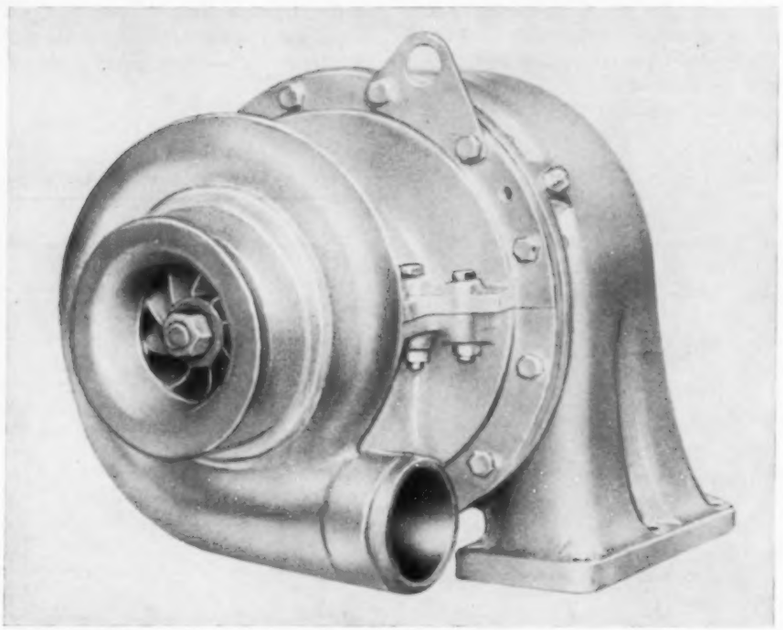


AiResearch Turbocharger Model F-51

AiResearch Turbocharger Model E-100



AiResearch Turbocharger Model B-140



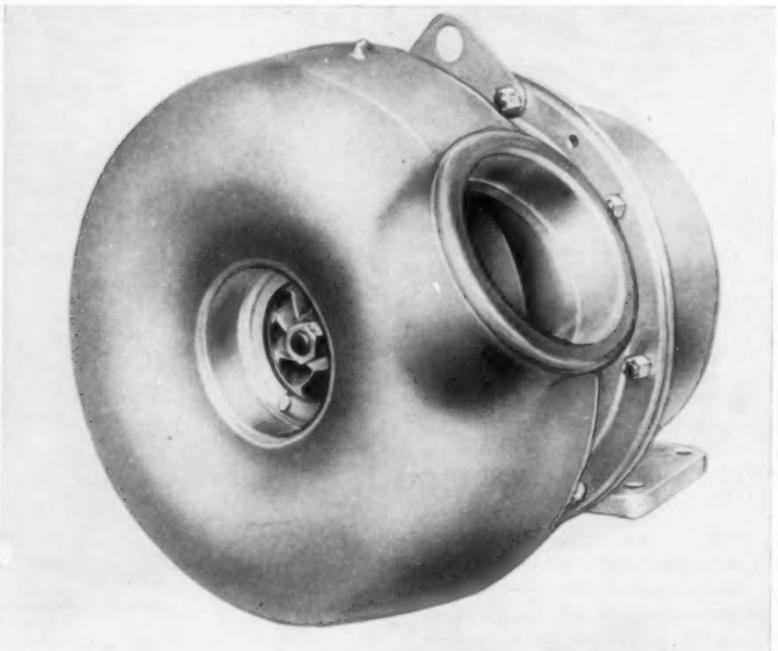
AiResearch Turbocharger Model C-60

THE Garrett Corporation's AiResearch Industrial Division, added five new turbocharger models to their product line in 1956. Present production includes the G-27, the F-51, C-60, A-60, E-60, B-100 and the B-140. Development work is progressing on additional models.

RANGE OF APPLICATION—These production models are applicable to the three basic areas of diesel engine usage: Stationary; automotive; and marine. They are applicable to both two-cycle and four-cycle diesel engines, and cover the basic range of from 60 to 700 horsepower diesel engines in single installations.

Impressive performance has been demonstrated in multiple installations for larger diesel engines with inherent advantages: Greater reliability; Small, compact installation; Improved air distribution; Better acceleration characteristics; Simple, easy installation.

SPECIAL DESIGN FEATURES—AiResearch's initial turbocharger models incorporated the toroid-



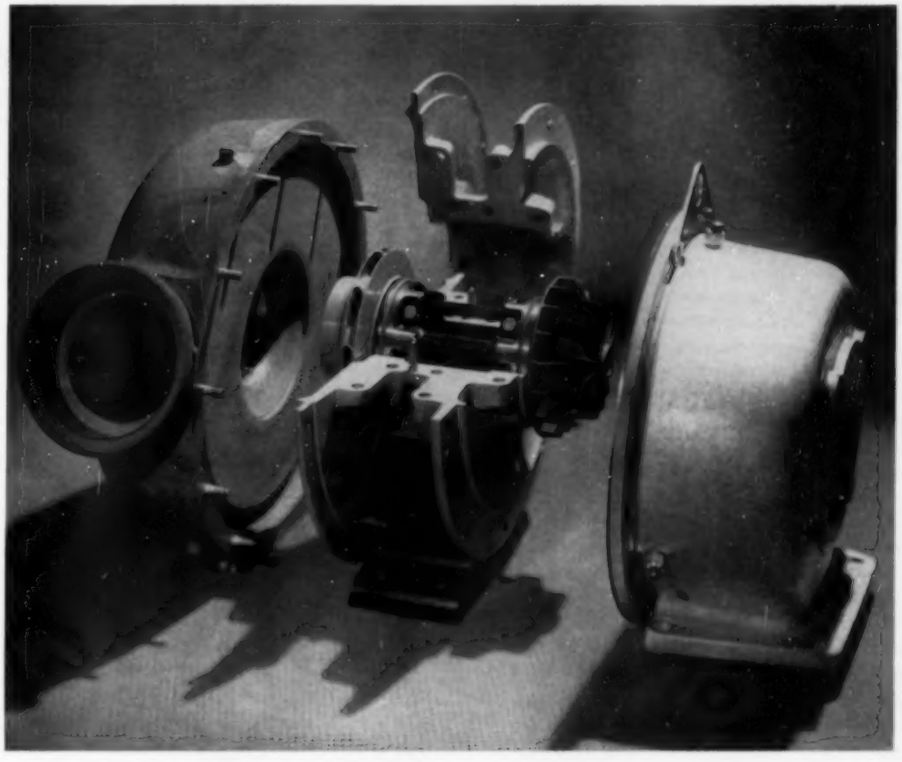
AiResearch Turbocharger Model A-60

al compressor housing. Some newer models are built with scroll compressor housings which afford, in many installations, reduction in weight and overall dimensions. Both types are proving efficient in solving specific installation and air flow requirements. All AiResearch turbochargers are air cooled, providing complete freedom from water cooling requirements. This greatly simplifies installation factors and has the added feature of eliminating plumbing and other provisioning for greater cooling capacities associated with water or oil cooled units. AiResearch units can take full advantage of blow-down or pulse energy where such an installation is desired.

Design and precision engineering and manufacture of essential parts, such as compressor impellers and turbine wheels, accommodate the high density ratios new required, as well as those anticipated for future applications. A broad range of operating characteristics, with accompanying high efficiency, is inherent in all models designed for general applications by use of the shrouded, backward-curved impeller wheel. This feature has been proved under heavy duty service and extreme operational environments. The radial, inward-flow turbine wheel design is incorporated in all models. This combination has proved particularly effective in providing properly matched turbine and compressor characteristics for maximum performance, reduced fuel consumption, cooler delivery air flows, cooler engine temperature, and extended service life.

Simple lubrication provisions, using only the basic engine lubricating system, eliminate any requirement for a separate oil reservoir. The system also eliminates the requirement for high pressure air for lube purposes. Inherent to the design of AiResearch turbochargers is the fact that only low volume oil flow is necessary because the lubricating oil is not required to perform cooling functions. The oil is effectively sealed away from the compressor housing. Precision journal type bearings are used, fabricated from the finest material available. Because of the wide rpm range possible for all AiResearch turbochargers, they are particularly well suited for applications involving high altitude operations. AiResearch turbochargers can easily accommodate substantial changes in rpm to provide improved diesel engine performance whether operating at sea level or altitude.

SIMPLE SERVICING AND REPAIR – AiResearch's simplicity of design has been continued in new models. No special tools are required for servicing. Nozzles may be changed easily and quickly. Certain units incorporate rotating group cartridges (including bearings, bearing carriers and seals) which are assembled and balanced at the factory, and may be replaced easily in the field as a unit. Field maintenance and repair has received full consideration in the design of all AiResearch turbochargers. The split main housing, the rotating cartridge assembly, the simple nozzle installation, and the use of precision bearings, are all examples of AiResearch's continuing efforts toward design and service simplicity. Photographs of current production turbochargers, and condensed specifications, are shown on these pages.



View of an AiResearch Industrial Division A-60 turbocharger, showing the compressor section (left), the center section, with compact rotating cartridge assembly, and the turbine section (right).

AiResearch Turbocharger Model B-100

BASIC SPECIFICATIONS FOR AIRESEARCH TURBOCHARGERS

MODEL	G-27	F-51	C-60	A-60	E-100	B-100	B-140
Diameter–in. nom.	8.5	10.0	11.5	15.25	15.1	15. 4	16.0
Length–in.	8.8	10.5	12.9	16.75	14.7	17.10	21.75
Weight–lb.	33	40	95	125	112	135	195
*Delivery Airflow lb/min. (Standard Conditions)	15- 27	29- 51	30- 60	38- 60	50-100	60-100	120-140
*Horsepower Range (4 stroke Diesels)	75-160	145-306	150-360	190-360	250-600	300-600	600-840

*The above performance ratings are approximate and may be exceeded, depending on analysis of individual problem statements.

DE LAVAL

TURBOCHARGER

De Laval turbochargers have been designed and developed specifically for high-pressure supercharging service. They are available in several sizes, with airflow capacities ranging from 2,000 to 15,000 cfm—each capable of producing (continuously) a pressure ratio of 3:1. With the De Laval turbocharger the engine manufacturer can now use inlet manifold air pressures of 30 psig, which enables him to increase his engine rating to a BMEP of well over 200 psi without increasing the thermal loading of the engine, while at the same time a substantial reduction in specific fuel consumption is effected. The high pressure ratios of the De Laval turbochargers also make possible high altitude installations in which the engine does not have to be derated, but can develop full sea level power. Figure 1 shows one of the De Laval turbochargers with the turbine admission casing removed, exposing the turbine nozzle ring and the turbine wheel to view.

One of the outstanding characteristics of the De Laval turbocharger is the high efficiency of the turbine and the compressor, which is the result of many years of painstaking research and experimental work. The compressor is the mixed-flow type, so-called because the air enters axially and flows through and out of the impeller partly axially and partly radially. This type of compressor was originated by De Laval more than twenty-five years ago, and has gradually been refined aerodynamically and improved structurally, until today the efficiencies and performance characteristics obtained are substantially better than those that can be achieved with conventional turbochargers. As will be seen from the sectional drawing, Figure 2, a departure from conventional practice was also made in the design of the turbine, because it was found that the desired turbine characteristics and high turbine efficiency could not be obtained by using the conventional axial-flow type of turbine.

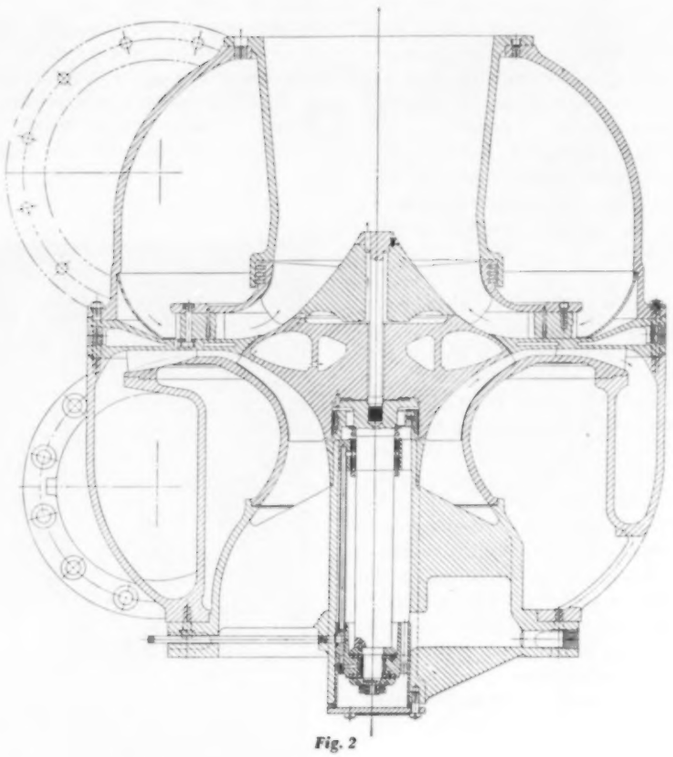
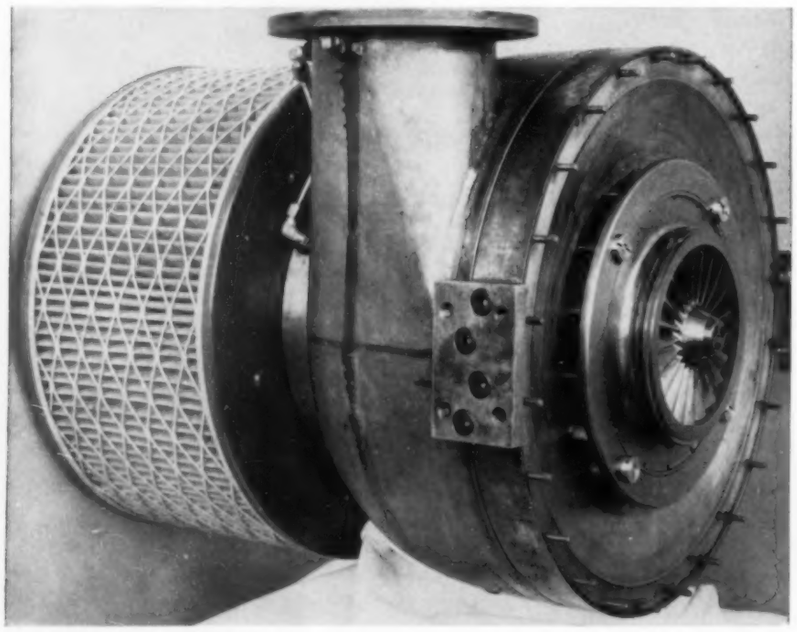


Fig. 2

The mixed-flow centripetal turbine—which De Laval was the first to develop, beginning as long ago as back in 1928—was found to be much more suitable for service in exhaust-gas-turbine-driven superchargers. One of the many attractive features of the centripetal turbine is the fact that its blades are very rugged and few in number.

Fig. 1



In comparison with other turbochargers presently on the market, the De Laval type is unique with regard to the construction of its rotor. The mixed-flow impeller and the centripetal turbine wheel are combined in a single rotor structure in which the compressor blading is carried on one side of the rotor hub and the turbine blading on the opposite side. This arrangement eliminates parasitic losses such as turbine and compressor leakage, which are unavoidable in conventional designs employing separate compressor and turbine rotors. By eliminating these losses, the turbine and compressor efficiencies are substantially improved, over and above the improvements already achieved by the aerodynamically highly improved mixed-flow compressor blading and the refined centripetal turbine blade configuration. This so-called "Monorotor" construction offers the additional advantage of extreme simplicity. The blades of both the compressor and the turbine are open along their entire tip contours, and their configuration prevents accumulation of dirt, with its resulting loss of performance.

The overhung rotor is bolted to the end of the shaft. The shaft is journaled in two bearings, located on the cold side of the rotor and contained in a common bearing housing that is an integral coaxial part of the compressor inlet casing. Both bearings are of the steel-backed, copped-lead-lined type. The end faces of the outboard bearing serve as thrust bearings by cooperating with thrust collars carried on the shaft, thus serving to locate the

rotor and carry its slight axial thrust. Both bearings are so arranged that they can be removed and inspected in a few minutes, merely by taking off the bearing end cover and without further dismantling the unit. Oil to the bearings can be supplied from the engine lubricating system, or, if desired, a separate, self-contained lubricating system can be furnished with the turbocharger.

The turbine nozzle box receives the engine exhaust gases in a tangential direction, through a single inlet, and contains the turbine nozzle guide vanes which provide for full admission in all applications. These guide vanes are arranged between two radial walls, and are so mounted on one of them that they can readily be pivoted to change the nozzle area. This feature eliminates the need for installing different nozzle rings to adapt the unit to different operating conditions, and permits rapid matching of engine and turbocharger. In some units a mechanism has been incorporated which permits adjusting the guide vane position from the outside, during operation of the turbocharger.

This externally-adjustable guide vane mechanism is invaluable when used as a tool to rapidly perform a series of tests leading to the best matching of turbocharger and engine. It can also be used for varying the turbocharger rpm with changing engine load or speed, to achieve various engine operating characteristics, such as high torque at low engine rpm.

The guide vanes direct the flow of exhaust gases radially inward into the turbine blades, from where they are discharged into the passages formed by the blades of the turbine wheel. The exhaust gases are then discharged into an exhaust diffuser, which is coaxial with and a part of the turbine housing. This diffuser serves to recover some of the kinetic energy represented by the leaving velocity at the discharge from the turbine blades, and to convey the gases to the turbine discharge opening.

The turbine housing is made from a heat-resisting alloy, and is insulated and lagged instead of being water-cooled. The turbine nozzle box is separated from the compressor housing by a central partition diaphragm, which is hollow for internal water circulation. It is the only water-cooled part of the entire unit. Tests have shown that the amount of heat rejected to the small quantity of cooling water required is insignificant compared with the heat carried away in the cooling water for the commonly-used turbine casing cooling jackets.

Due to carefully selected, highly heat resisting materials, the turbine is capable of safe operation with the highest temperatures encountered in Diesel engine service. The full admission of the turbine and its undivided nozzle box makes the DeLaval turbocharger different from conventional designs. Full admission is necessary if maximum turbine efficiency is to be achieved. With the conventional "blowdown" system full admission is impossible, because groups of two or three cylinders are connected, through individual manifold branches, to separate nozzle box compartments. This involves partial admission and pulsating gas flow through the turbine, both of which adversely affect turbine efficiency.

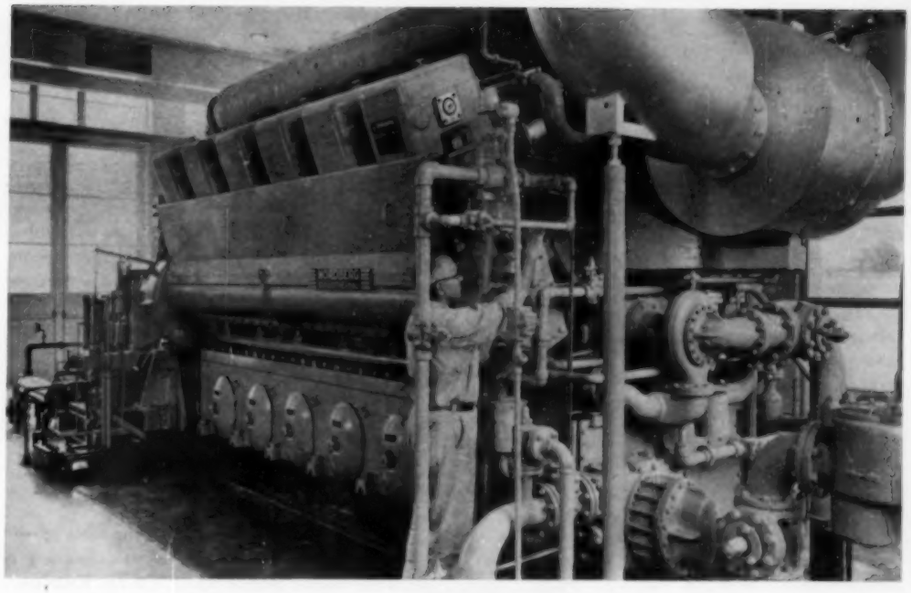


Fig. 3

Because of its extraordinarily high combined efficiency and full admission, the De Laval turbocharger has made possible for the first time the widespread commercial use of the so-called "constant pressure" system. In contrast to the blowdown system, with the constant pressure system the exhaust gasses of all cylinders are collected in a common manifold which delivers them to the single turbine inlet of the turbocharger, as shown by Figure 3 (depicting a twelve-cylinder engine turbocharged by a De Laval unit.) While the constant pressure system does not permit the utilization of the energy in the exhaust pulsations, the single exhaust manifold characteristic of this system has the advantage of being more reliable and much simpler and cheaper to manufacture than the complicated multi-branched manifold required for the blowdown system. If the turbocharger pressure ratios are high, there is little justification for attempting to recover the energy in the exhaust pulsations by means of the conventional blowdown system, because at high pressure ratios the energy in the exhaust pulsations represents only a very small percentage of the total exhaust energy that must be made available to the turbine.

In some cases it is desirable to combine the advantage of high turbine efficiency, derived from steady-flow operation, with that of the blowdown system—the utilization of the pulsating energy. This combination has been achieved by De Laval's "pulse converter." As the name "pulse converter" implies, this device converts the pulsating energy in the exhaust gases into a pressure rise, thus making available to the turbine the energy in the exhaust pulsations in the form of increased pressure, under conditions of full admission and steady flow. Various types of pulse converters have been developed for a variety of applications—from the simple pulse converter adaptor, with which the conventional multi-branched manifold can be retained, to the single manifold eductor-type of pulse converter. Where the customer wishes to avail himself of the advantages to be derived from the use of a pulse converter, De Laval furnishes all the necessary exhaust manifold design data as a part of the application engineering.

The De Laval turbocharger has more than doubled the output of many a four-cycle production engine, and in some cases has increased the power rating of an atmospheric-aspirated engine threefold. In addition, major improvements have been made in the fuel consumption and other engine operating characteristics.

Up to recently it was thought impossible to turbocharge two-cycle engines, chiefly because their low exhaust temperatures make it difficult for any turbocharger to produce the necessary differential between intake and exhaust manifold pressures. With the high combined efficiency of the De Laval turbocharger this situation has changed. The results of several installations clearly prove that this efficiency enables the De Laval turbocharger to serve as the sole source of air supply, even for high-speed two-cycle engines.

We have an experimental installation of a high speed two cycle engine using a De Laval B8 turbocharger as the sole source of air supply. The output of this engine was increased well above 200% of its standard rating. Other turbocharged two-cycle engines make use of the De Laval turbochargers, operating them in series with the engine driven positive displacement blower, which supplies the air at low-load operation and "floats on the line" at medium and high loads. As the result of this pioneering work, the two-cycle engine can now be designed for turbocharged operation, thereby deriving the many well-known benefits which have made the turbocharging of four-cycle engines an economic necessity.

ELLIOTT CO.

EXHAUST GAS TURBOCHARGERS

THE Elliott turbocharger is a distinct form of supercharger, taking its name from its turbine drive. Unlike most superchargers it has no mechanical drive connection with the engine. Further, it converts into useful work the kinetic energy of the exhaust gas which would otherwise be wasted. Thus turbocharging is in large part, a costless by-product of engine operation.

The Elliott turbocharger is used in conjuction with two-and four-cycle diesel engines. The engine exhaust gases are put to work turning the rotor of a gas turbine. Integral with the rotating turbine shaft is a centrifugal blower which produces a pressurized supply of fresh air.

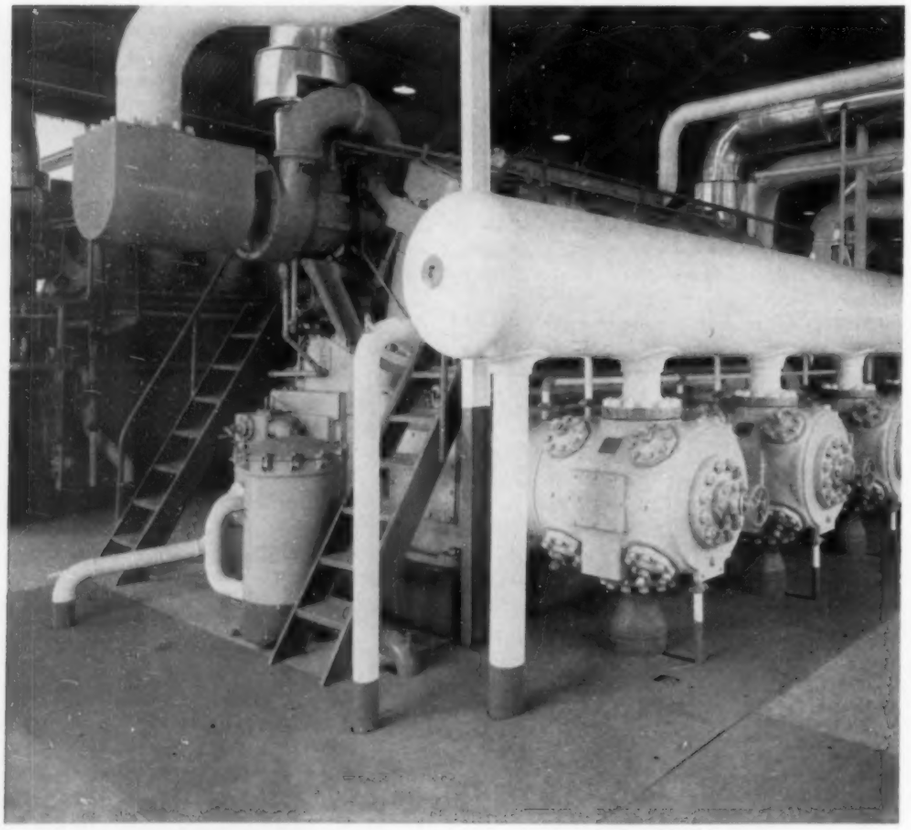
This air scavenges and cools the cylinders and charges them with high-pressure air during the suction stroke. The resulting higher density of air permits higher BMEP and yields greater horsepower output from the engine.

Three types of turbochargers are built by Elliott Company. The *high-pressure* design (Model H) will deliver blower pressures up to 30 psig, permitting engine ratings over 200 BMEP. With this unit, increases in rated horsepower in excess of 100 Percent above unsupercharged engines are commonplace. For lower pressure diesels, the *low-pressure* unit (Model L) is available, and for *high speed* engines the Model M is recommended.

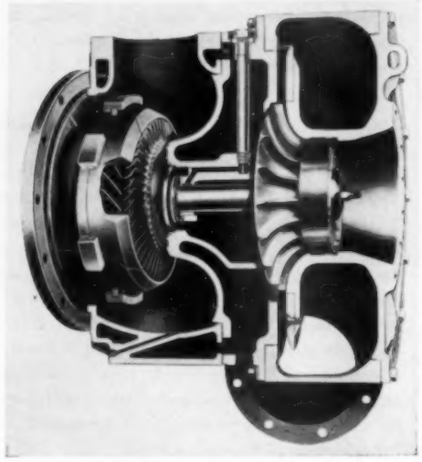
Elliott turbochargers of either design include every development proven during the company's 16 years of application and engineering experience in this field. Over 12,000,000 hp. of Elliott-turbocharged diesels are now in service.

CONSTRUCTION—As shown in the table on the opposite page, several sizes of Elliott turbochargers cover all engine ratings above 150 hp. Each standardized size, by variation of a few internal parts, is adaptable to a range of engine ratings. Standardized design also permits a variety of mounting and piping arrangements and numerous assembly positions for turbine inlet and blower discharge.

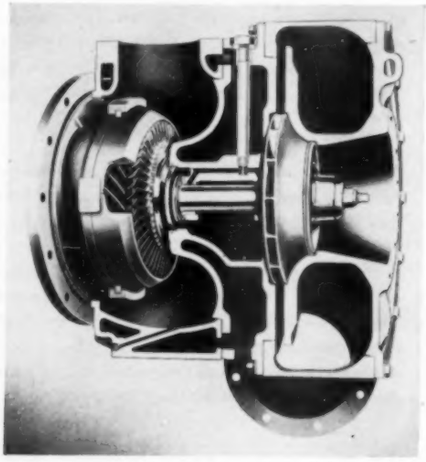
Turbine blades and turbine disc of the larger sizes are machined from high-strength heat-resisting, chromium-nickel-molybdenum alloy. Blades are securely fastened in the turbine disc, and provision made to dampen blade vibrations. The smaller size



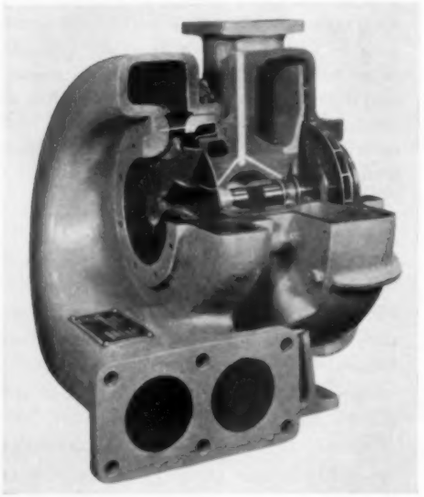
Two Elliott turbochargers serve each of the seven gas-engine compressors in this pipeline compressor station.



High-pressure—Exhaust-driven turbine at left, and centrifugal blower, right, are mounted on a sturay common shaft. Support for precision sleeve bearing is between turbine and blower rotors.



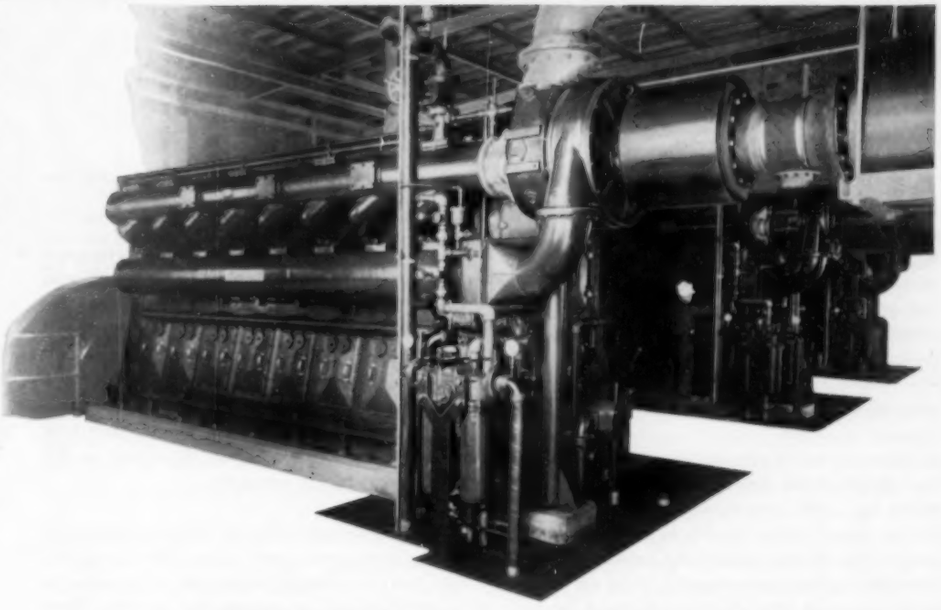
Low-pressure—Basically similar to the high-pressure design. Note the closed-type blower impeller.



High-speed—Especially designed for application to high-speed diesels. This unit features an integral precision-cast turbine rotor.

machines are equipped with integral precision-cast turbine rotors. Blower impellers are carefully inspected by radiograph and proof-speeded before assembly. The entire rotor is statically and dynamically balanced to close limits before assembly in the turborcharger. The rotor is supported by a water-cooled intermediate casing. Shaft bearing journals run in steel-backed precision sleeve bearings. A thrust bearing absorbs any end thrust of the rotor. Bearings are lubricated from the engine oiling system or, in some cases, a separate system is used.

Blower casing is of high grade cast iron. The larger machines have water-cooled turbine casings. The turbine inlet casing, containing the exhaust passages from the exhaust manifolds to the turbine nozzles, is of cast steel; it is uncooled but mounted to provide for free expansion. Turbine nozzle ring is made of high temperature materials to resist distortion. An air inlet filter or silencer can be furnished on larger sizes when required. Necessary special tools are available.



This neat generating station boasts three 1423 bhp Elliott-turbocharged diesels

ADVANTAGES OF TURBOCHARGING

Increased Engine Output—Increased continuous and maximum output with an engine of a given displacement and speed or conversely a smaller and lighter engine for a given output, without harmful effects to the engine. With engines of modern design, this increase in power is usually up to 100 percent. Successful applications can be made to engines for practically any service, without limitation as to type, size, or speed. Relatively few internal changes to the engine are required.

Rating of engines operating at high altitudes can also be increased. Sea level rating can be restored to engines at altitudes of about 12,000 to 14,000 ft. At lower levels, outputs in excess of unsupercharged sea level ratings are possible.

Greater Overload Capacity – Greater overloads above continuous rating can be carried, under favorable thermal conditions. When the quantity of fuel is increased, the blower automatically provides more air at higher pressure. The fuel consumption and exhaust temperatures do not increase as rapidly under overloads as they do with unsupercharged or mechanically supercharged engines.

Constant Torque at Reduced Speeds—At reduced speeds down to 50 percent or less, engine torque can be maintained constant—and in some cases actually increased—without exceeding established temperature limits.

Fully Automatic Operation – Operation of the turbocharger is fully automatic at all loads; no control devices are necessary. Speed, air quantity, and charging pressure follow engine load and speed changes very promptly, due to the low inertia of the turbocharger rotor. The turbocharged engine will carry suddenly applied loads as readily as an unsupercharged engine.

Less Engine Maintenance—Experience has shown that the turbocharged engine is equally as reliable as an unsupercharged engine, and that no additional operating difficulties or maintenance costs are involved. Pistons, cylinder heads, and particularly exhaust valves, are often found to be in relatively better condition, due to efficient scavenging. The turbocharger itself is a rugged and relatively simple machine requiring only a normal amount of operating and maintenance attention.

Less Fuel and Lube Oil Consumption—Fuel and lubricating oil consumption are decreased. The mechanical efficiency of the turbocharged engine is higher, and the internal lubricated surfaces smaller, since more power is produced in a given cylinder displacement. Normally, fuel consumption at rated capacity will be less than with unsupercharged engines, and the fuel consumption curve per bhp, per hour is considerably flatter, resulting in savings as high as 25 percent at ¼ load. Also, fuel consumption is less at all loads, than with other methods of supercharging.

Quieter Operation—Exhaust pulsations are dampened considerably in passing through the turbine, making it possible to use a more simple exhaust muffler, or in some cases entirely dispensing with the use of other silencing equipment.

Suitable for Reversing Engines—The turbocharger always rotates in the same direction regardless of engine rotation. It is thus ideally suited for application to direct reversing marine engines, as contrasted to mechanically supercharged engines.

No Increase in Engine Dimensions—Due to its small size and light weight, the turbocharger is usually mounted directly on the engine frame without increasing the overall limiting dimensions of the engine.

Less Heat Loss to Cooling—Less heat is absorbed in the engine jacket cooling water, since relatively more heat is absorbed by the scavenging air and goes into the exhaust gas, some of which is usefully employed in the turbine. This results in smaller size of heat exchangers for a given output.

RATINGS AND SPECIFICATIONS OF ELLIOTT TURBOCHARGERS

Turbocharger Model	Maximum Continuous Inlet Temp.	Pressure Ratio Range	Approx. BMEP	Approx. Engine HP Range	Number of Inlet Ports
M-5	1350 F.	1+ to 1.7	110 psi	160-325	1-2
M-10	1350 F.	1+ to 1.6	to 140 psi	250-600	1-2
L-10	1100 F.	1+ to 1.6	110 psi	225-550	1-2-3-4
L-20		1+ to 1.6		300-850	1-2-3-4
L-40		1+ to 1.6	to	700-1450	1-2-3-4
L-60		1+ to 1.6		1200-2500	1-2-3-4
L-100		1+ to 1.6	150 psi	2000-4000	1-4
H-15	1200 F.	1.4 to 2.2	130 psi	300-700	1-2-3-4
H-30		1.4 to 3.0		450-1000	1-2-3-4
H-35		1.4 to 3.0		600-1400	1-2-3-4
H-50		1.4 to 3.0	to	700-1900	1-2-3-4
H-70		1.4 to 3.0		1000-3000	1-2-3-4
H-110		1.4 to 3.0	180 psi	2400-5000	1-4
H-31	1300 F.	2.0 to 3+	160 psi	700-1200	1-2-3-4
H-36		2.0 to 3+		1100-1800	1-2-3-4
H-51		2.0 to 3+	and	1400-2600	1-2-3-4
H-71		2.0 to 3+	UP	1600-4500	1-2-3-4
H-111		2.0 to 3+		3000-6000	1-4

BROWN BOVERI

MORE than twenty years ago Brown Boveri started to produce exhaust gas driven turbo-chargers. Based on approximately fifteen years of experience in service, maintenance and performance a new series of turbochargers were designed and built in 1944. Today Brown Boveri turbo-chargers are available for 150 up to 5500 hp. supercharged output. They are used in all fields traction, ship propulsion, stationary power plants, and high altitudes of installation.

A large number of identical diesel engines is seldom required for the same application, except where low-power traction engines are concerned. On the other hand, a number of partially or even completely different turbo-chargers must be available for a given type of engine if its use is not to be restricted. Special designs in small batches are normally not economical and must be tested very thoroughly each time. Brown Boveri found an early solution to this problem by assembling turbo-chargers from standard parts built on the unit construction principle and which could be applied to a very wide range. The most suitable casings, wheels, and nozzle rings and diffusers for the case in question are selected and the casings so bolted together that the connecting branches point in the required direction This type of assembly has proved very satisfactory in practice.

The new range of turbo-chargers, comprising seven different sizes, is designated VTR. The different sizes of compressor and turbine can cover practically the entire range of operating requirements for two- and four-stroke engines with a satisfactory efficiency. In view of the multifarious operating requirements which these machines had to meet it was hardly expected that no initial difficulties would be encountered. Such difficulties as did occur were, however, overcome.

In evolving the new range the following principles, among others, were taken as base: Everything that had proved satisfactory in the earlier types was to be retained and everything else omitted. Every effort was to be made to simplify maintenance. All requests, with regard to the method of fitting on the engine, were to be considered and included, as long as they did not jeopardize economy.

The design of the new turbo-chargers is in principle the same as hitherto and substantially the same for all sizes. New parts which have been added increase the pressure range and allow a low-pressure charger to be converted to a high-pressure charger. A few details are discussed hereafter.

The bearings are fitted one at each end of the rotor and are therefore easily accessible. They are fitted in damping elements which prevent damage to the bearings due to vibration of the shaft and shocks of all kinds. The lubrication of the bearings is independent of that of the engine. Lubricating discs fitted one on each end of the shaft supply oil to the bearings—for large machines pumps are used instead of discs. The bearing casing acts as an oil tank and is completely sealed, except for the shaft bore. On the compressor side, the lubricant is cooled by air flowing over the bearing casing and, on the turbine side, by the water in a jacket around the casing. Cooling coils or oil pipes, easily damaged by shock, are dispensed with.

The assembly and dismantling of the turbo-charger is simple. To dismantle, the lubricating discs and bearing assemblies are removed, then the inner blower casing extracted, whereupon the complete rotor, together with the heat-insulating barrier, can be removed. Special devices and tools supplied with the turbo-chargers facilitate this work and prevent damage to the glands. It should be noted that neither gas, charging air, nor cooling water connections need to be disconnected, except in the case of small chargers where the charging air pipe must be disconnected as the compression casing is in one piece.

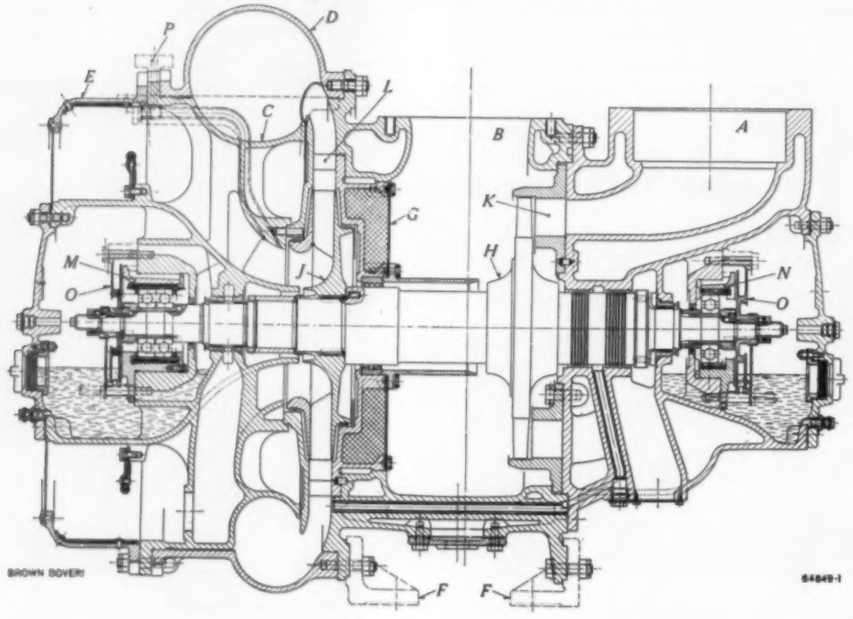
To deaerate the engine crankcase there is a connection on the charger leading to a point, before the compressor impeller, where the greatest vacuum prevails. Many designers use this vacuum to extract the gases which leak into the crankcase between the piston and walls of the cylinders. This prevents oil vapor escaping into the engine room with the gas. It has been a matter of great controversy whether this extraction increases or not the risk of an explosion, as, with the crankcase under vacuum, air can leak in and form an explosive mixture with the oil vapor. If the connection is used, a good oil separator must always be fitted in the pipe since oil vapor would mix with soot in the charger and cause deposits to form in it.

Supercharging of diesel and gas engines is well established today and has already proven its advantages many times even for the low pressure system where the gain by using this system is not as pronounced as for high pressure supercharging, turbocharging in high altitudes and some special applications. In recent years excellent results have been obtained with turbocharged two cycle engines. Brown Boveri has participated in this development and worked together with practically all leading American and European manufacturers of two cycle diesel engines.

Section through an exhaust-gas turbo-charger type VTR 320

A = Gas inlet casing, water cooled
B = Gas outlet casing, water cooled
C = Inner blower casing
D = Outer blower casing
E = Suction and silencer hood
F = Feet for fixing
G = Heat insulating barrier
H = Shaft with turbine wheel
J = Blower heat
K = Nozzle ring
L = Duffuser
M = Bearing assembly, journal and thrust bearing
N = Bearing assembly, journal bearing
O = Lubricating disc
P = Connection for deaerating engine crank-case

The drawing shows a turbo-charger for low pressure operation with a compression ratio up to 1.5 on the air side. For the high-pressure type with pressure ratios up to 2.2 an open-sided centrifugal compressor and shorter turbine blades are used instead of those shown here. The external dimensions of the charger and the connections are the same in each case. The maximum allowable temperature for the first case is 550°C continuously and 600°C for a short period, and in the second case 600°C and 650°C, respectively.

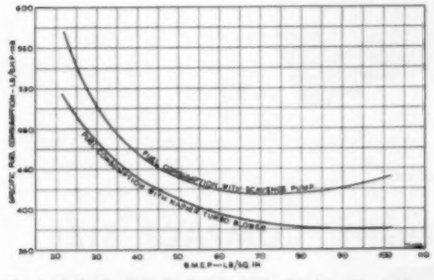


NAPIER

THE demand for greater power from smaller engines has been incessant since diesels were first developed. This demand arises, not only from the constant need for ever lower capital and running costs, but also from the necessity to conserve engine weight and installation space—factors of vital importance in marine and rail-traction applications. Pressure-charging by turbo blower enables the required power to be obtained from smaller and cheaper engines without increasing the specific fuel consumption, which may in fact be reduced.

Napier turbo blowers have earned a sound reputation as effective and reliable units for increasing the power of diesel engines by 60% or more. They are in use in more than 71 countries, and have widened appreciation of the real economic benefits of turbo pressure-charging.

Among the engines for which Napier turbo-blowers have been chosen are the Kahlenberg Model "E" series. These start, and operate throughout their entire speed range, without a scavenge pump, blower, auxiliary drive or any other device to assist the turbo-blower.



Typical Fuel consumption curves showing the saving achieved by using a Napier turbo-blower.

The Napier range includes turbo blowers that can be applied singly to four- and two-stroke diesel engines with outputs from about 140 to 4,000 b.h.p. By using two or more turbo blowers, turbo pressure-charging may be extended to engines with outputs much greater than 4,000 b.h.p.

Napier turbo blowers are available in three series, T.S., M.S., and H.P., each operating at different pressure ratios, and in seven basic frame sizes which together cover a wide range of free air capacities.

All the blowers are basically similar in design, each consisting of four castings bolted together to house a single-stage, axial-flow exhaust gas turbine driving a centrifugal air compressor. Exhaust gases ducted into the turbine inlet casing are directed through the blades of a turbine wheel by a nozzle ring, and leave the unit through the turbine outlet casing. Rotation of the turbine wheel by the gases drives the compressor impeller, drawing air through the compressor inlet, compressing and passing it out of the unit through the diffuser and delivery volute in the compressor outlet casing.

SIZES 90 TO 400—The turbine wheel and air impeller are mounted on a steel shaft carried in two ball bearings, one located in the compressor outlet casing and the other in the turbine inlet casing. The former locates the shaft and takes the small residual axial thrust while the latter is permitted slight axial movement to accomodate the different thermal expansions of the components.

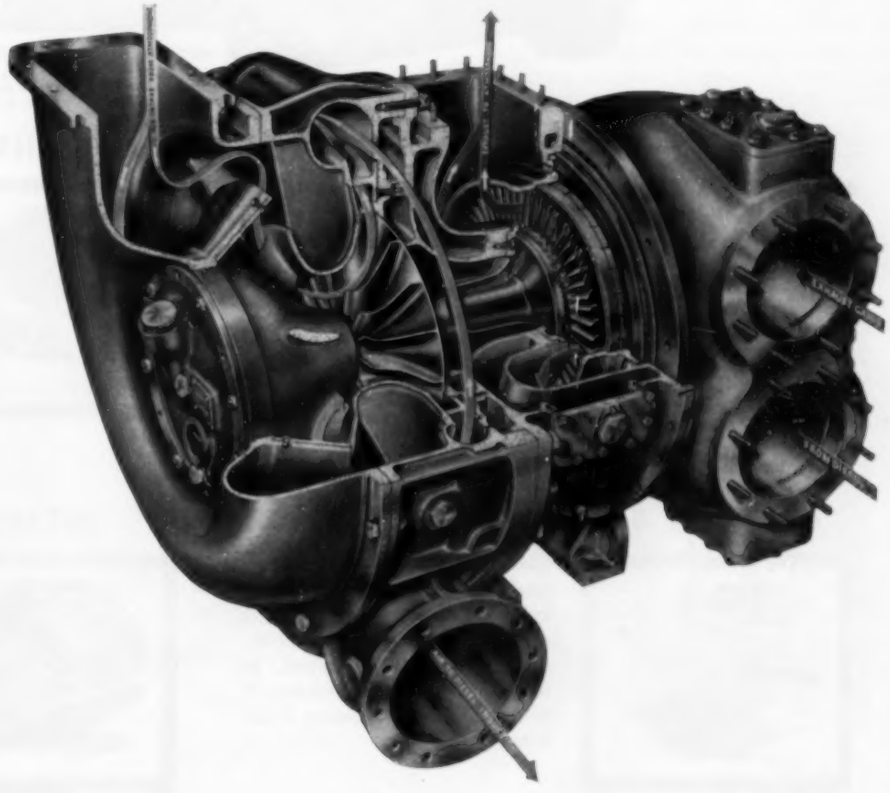
Discs mounted on each end of the rotor shaft run in separate oil reservoirs and act as independent oil pumps for each bearing, and air-pressurized oil seals prevent the oil from communicating with the delivery air or the exhaust gases. To ensure long life the turbine parts are constructed of heat-resisting materials and the turbine casings are water cooled.

The compressor impeller is an aluminum alloy forging with a labyrinth-type seal positioned to minimize the axial thrust. Two types of compressor inlet are available; an aluminum alloy casing with provision for connection to air ducting, or an air filter/silencer with alternative elements.

Adaptability to all installations is ensured by the design of the four main casings, each of which may be assembled in any of twelve circumferential positions, and universal mounting facilities are given by brackets that may be bolted at suitable positions on the turbine outlet casing.

SIZES 500 AND 600—In these frame sizes the rotor assembly is supported in plain sleeve-type bearings mounted in spherical housings which permit some universal movement in sockets in the casings, and also facilitate maintenance of the bearings. Lubrication is by external engine—or auxiliary-driven pumps that deliver oil to connections on the end covers, the oil draining back to the external reservoir through large connections at the lowest points of the covers.

CHARGE COOLING—In installations using turbo-blowers with pressure ratios of much more than 1.5:1 it is advantageous to cool the charge air after compression and before admission to the cylinders. Charge coolers can be supplied for each size of Napier turbo blower; these are suitable for fresh or sea water, and are available with single or double water flow arrangement.



MIEHLE-DEXTER

ROTARY POSITIVE SUPERCHARGERS AND SCAVENGING BLOWERS

GAINS of 50% or more in brake horsepower are possible when Miehle-Dexter Positive Displacement Superchargers are placed on Diesel Engines. Increased horsepower, of course, pays dividends in improved acceleration, fuel economy and more efficient performance.

Cramming more air into an engine's cylinders is the basic function of superchargers and blowers. This boosts compression, makes fuel burn better and produces the desired result—more power.

Miehle-Dexter Superchargers achieve increased horsepower by efficiently injecting as much as 150% of the normal air intake into the cylinders of the engine. This is accomplished throughout a wide range of engine speeds and air duct restrictions and at minimum cost.

Miehle-Dexter Superchargers are available in a range of sizes from 50 cfm. to 4000 cfm. at pressures up to 15 psig. Any model can be furnished in a variety of arrangements, such as self-contained or engine-lubricated, flange or port-mounted, belt or direct driven. Because the inlet and outlet ports are identical, rotation is in either direction. See Fig. C, opposite page.

Illustrated below Fig. A is an example of a Diesel Engine that obtained a substantial gain in horsepower through the addition of a Miehle-Dexter Supercharger. The Diesel engine is a stock model 8DA-1125 Buda engine designed for standard industrial and automotive operation. When naturally aspirated, it develops 288 horsepower at 2100 rpm. and weighs 11.8 pounds per hp. By the addi-

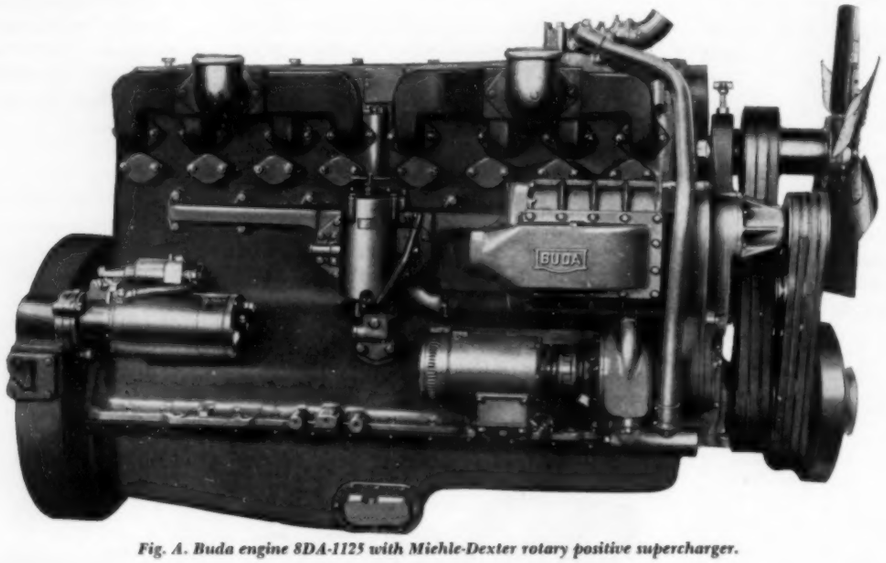
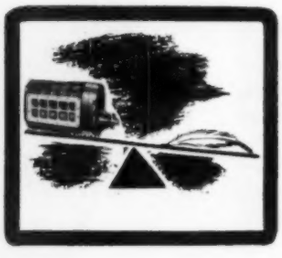


Fig. A. Buda engine 8DA-1125 with Miehle-Dexter rotary positive supercharger.

NO METAL-TO-METAL CONTACT

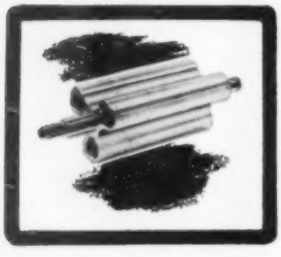
A patented synthetic rubber-grid seal, vulcanized directly to the metal surface of the end plate by special process, seals the ends of the rotors—eliminates metal-to-metal contact between rotor-end and plate. It's the key to longer service life and efficient performance for M-D aluminum blowers.

LIGHTWEIGHT, COMPACT SIZE



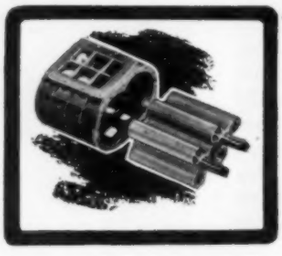
Lightweight and compact size are advantages enjoyed by M-D Blowers. This is made possible by the three-lobe rotor design operating at moderate speeds. These rotors are dynamically balanced and supported by heavy-duty antifriction bearings. Timing gears are precision matched for wear resistance and noiselessness.

FORMICA STRIPS PROTECT ROTOR



Clearance between rotor lobes and housing is practically zero. Wear strips are locked into the tips of the rotor lobes. Air leakage is minimized. In addition, maximum volumetric and adiabatic efficiency is assured.

INTERCHANGEABLE PARTS FOR ADDED CONVENIENCE



Accurate machining and standardized design allow interchangeability, easy field service. Maintenance engineers can field-install parts from one unit to another with a minimum of downtime—reducing maintenance costs.

tion of a Miehle-Dexter Supercharger, it develops 350 horsepower at 2100 r.p.m. and weighs only 10.2 lbs. per horsepower. Model No. is 8DAS-1125. Records show that the additional investment was extremely small when compared with the cost of completely redesigning engines to keep pace with the need for increased power required to meet today's operating conditions.

Miehle-Dexter Superchargers offer several exclusive design features. Moreover, these features described below contribute to the mechanical efficiency, higher speeds and compact design characteristic of M-D Superchargers.

EASY MOUNTING ON ENGINES—The case has identical inlet and outlet ports. This provides easy application of M-D Supercharger to an engine, inasmuch as it permits rotation in either direction.

The engine previously described (Fig. A) is typical of how a Miehle-Dexter Supercharger provides a substantial gain in horsepower with only a small additional investment. The exclusive features permit higher speeds and more compact design. Note how easily the M-D Supercharger blends in with the engine. Where space and weight is at a premium, these characteristics of Miehle-Dexter Superchargers are extremely important.

The accompanying chart (Fig. D) provides performance data concerning typical production models. Note that there are now 15 different models, each of which is plotted at 6 psig. Standard units are available for continuous use up to 12 psig. Blowers can operate up to 15 psig. on intermittent service.

2- AND 4-CYCLE ENGINES—The Miehle-Dexter Superchargers provide several advantages for use on 4-cycle engines. They are also used on 2-cycle engines, principally for scavenging air. On 2-cycle engines, the air ports may become partly clogged with carbon deposits. This condition requires increased air pressure if the same volume of air is to be supplied. The Miehle-Dexter positive displacement type blower provides this increased pressure automatically in this case.

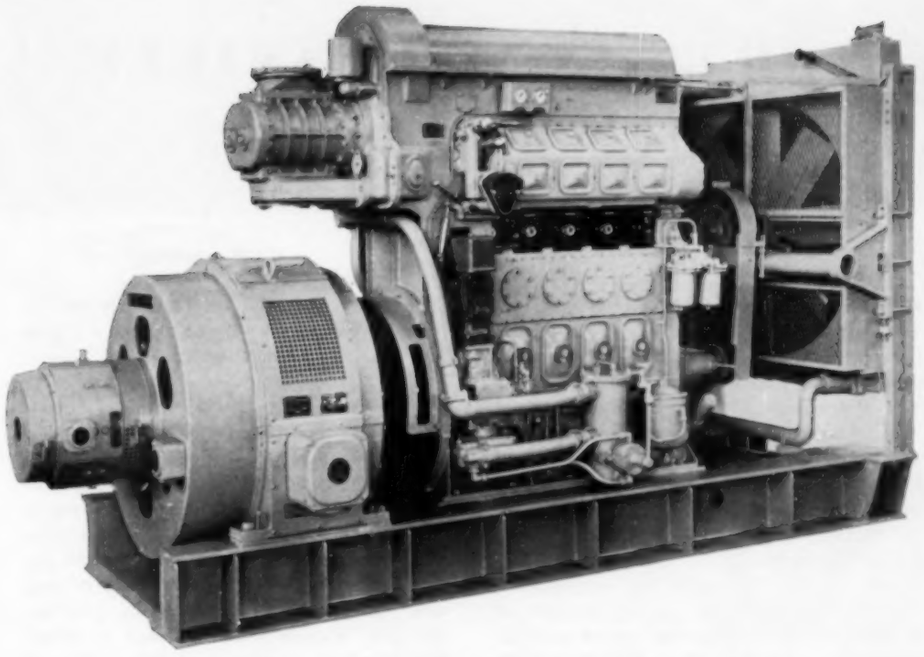


Fig. B. Fairbanks-Morse 38F5¼ opposed-piston 2-cycle diesel engine using Miehle-Dexter scavenging blower.

An example of how a Miehle-Dexter Supercharger is used as a scavenging blower is its use on the new Fairbanks-Morse Model 38F5¼ opposed piston engine. (See Fig. B, above.)

OTHER USES—Miehle-Dexter Superchargers are used as blowers on applications other than on Diesel engines. For instance, driven by a diesel engine, an M-D blower is used as a steam compressor in a vapor-compression cycle distilling unit. These blowers are also used in the aircraft industry for mobile ground equipment to provide compressed air for such as jet engine starting, cabin pressurizing tests, cooling of electronic equipment, etc.

They are also used in air conditioning, furnace or cupula blowing, chemical processing, sewage treating, soot blowing and countless other applications where air or gas is needed.

SERVICE—If service repairs are ever needed, the Miehle-Dexter units are easy to rebuild. Downtime is therefore minimized. Furthermore, Miehle-Dexter Superchargers may be factory-rebuilt and returned with a new unit guarantee.

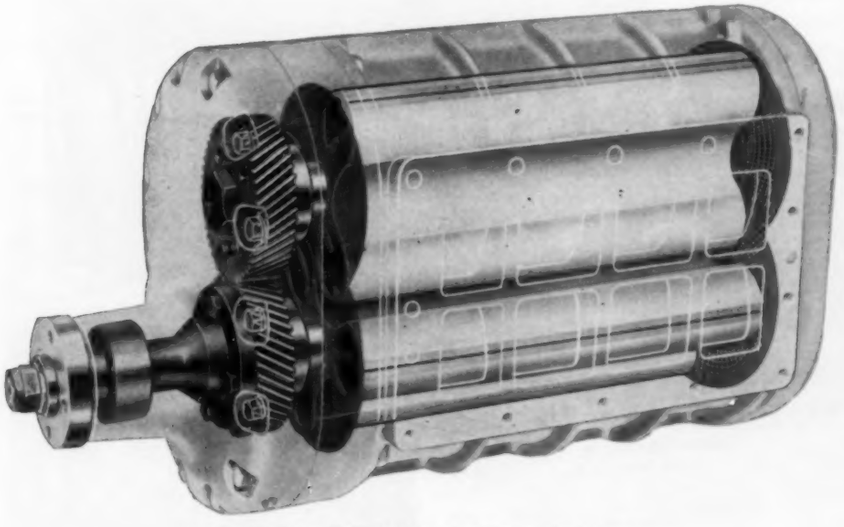


Fig. C. Miehle-Dexter belt-driven rotary positive blower.

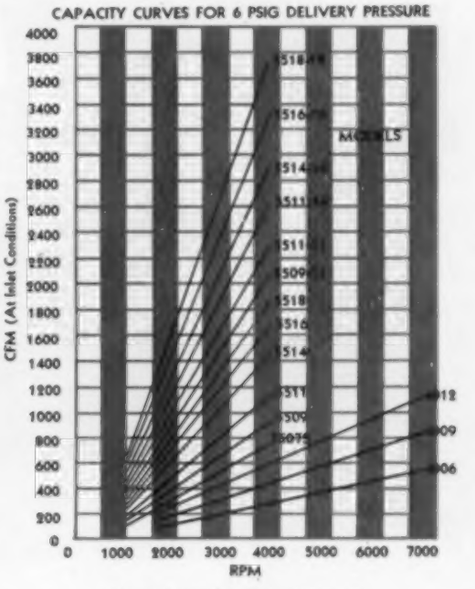


Fig. D. Supercharger performance.

ROOTS-CONNERSVILLE

POSITIVE DISPLACEMENT AND CENTRIFUGAL TYPE SCAVENGING BLOWERS AND SUPERCHARGER BLOWERS

THESE blowers are used for scavenging two-cycle engines, for supercharging the smaller sizes of four-cycle engines, and for overcoming loss of air due to altitude. Rotary positive displacemen blowers are built in a range of capacities from 5 cfm. to 50,000 cfm. while centrifugal blowers range from 2,000 to 100,000 cfm. Roots-Connersville recommends in any given case the proper type to give the best overall service.

For scavenging variable speed engines, with the blower driven by the engine, the rotary positive displacement type has the inherent characteristic of delivering air in proportion to the speed of operation, so that the volume of air matches the need of the engine at any speed. The pressure built up by the blower balances the resistance to flow of air through the engine ports, and no power is wasted developing excess pressure beyond that required.

These blowers operate efficiently at moderate speeds, which usually are from one to three times the engine speed. This permits simple and reliable driving from the engine through a step-up gear, V-belt, or chain drive.

Invented in 1854, the Roots-type rotary positive displacement blower originated in the Roots-Connersville organization, and the designation "Roots-type" has since been applied to all two-impeller type rotary positive displacement blowers regardless of the impeller shape. But the exact shape of the impeller is important for best overall performance under varying conditions of speed, pressure, and mounting applications. In each case, the most desirable impeller design is selected from previous experience and before shipment to the customer the blower is proof tested under operating conditions.

In all cases where there may be an advantage in taking the power for scavenging from a separate source, rather than from the diesel engine with which it is to be used, either the rotary positive blower, motor driven, as shown in photograph No. 1470, can be used, or, when electric power is not available, a smaller diesel or gas engine may be used to drive the scavenging blower. When it is advantageous to use a centrifugal blower, either from the standpoint of weight or space limitations, a motor driven installation, as shown by photographs No. H-312 and H-166 may be used. If preferred the blower may be driven by a steam turbine.

The impellers of the rotary positive displacement blowers do not contact each other nor the casing. The impellers are timed by gears mounted on the shafts at the proper place to best fit into the engine design. The gears are specially designed for smooth operation and are often spray lubricated from the engine oiling system. Materials for casings and impellers are varied to suit the requirements. Every application is investigated, and frequently blowers are specially designed to meet specific engine requirements as to blower mounting, drive, speed, arrangement of inlet and outlet connections, and other items.

Photo H-221—Type OIB Centrifugal Blower for diesel engine scavenging. Capacity 7950 cfm. at 2.85 lbs. pressure. Driven by 150 hp. motor through speed increasing gears, at 4620 rpm.

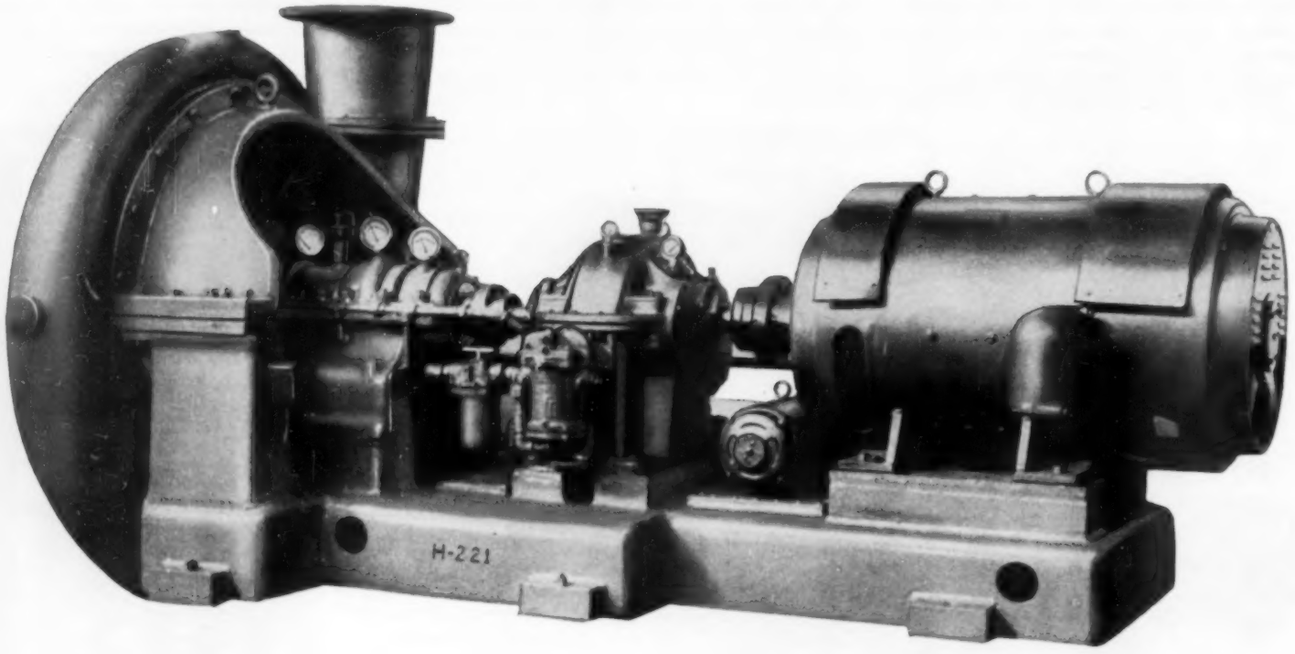


Photo No. H-166—R-C Centrifugal blower for scavenging a Marine diesel engine; driven through step-up gear by 200 HP D.C. motor. Blower capacity 10,000 to 16,000 CFM.

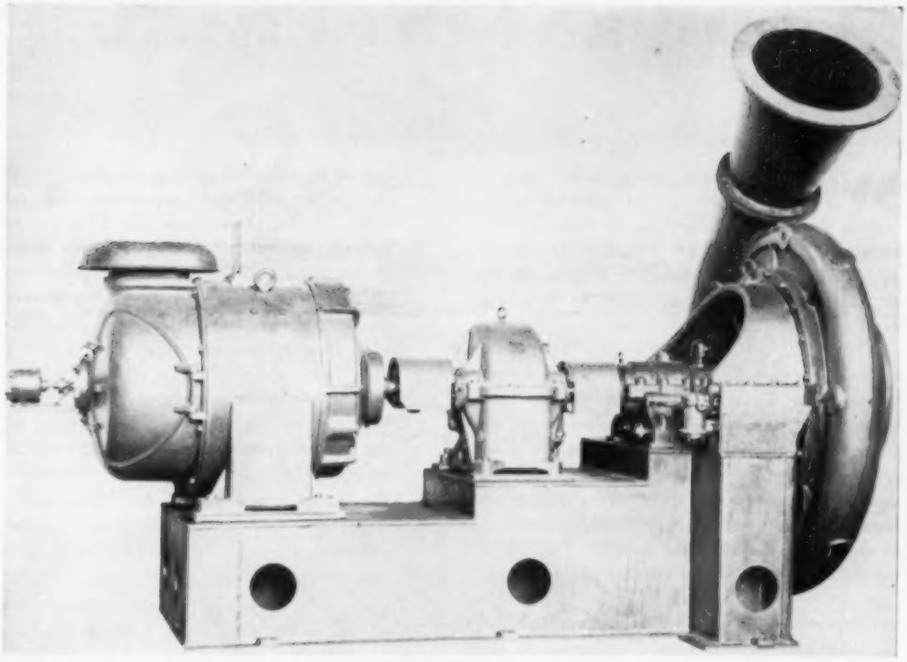
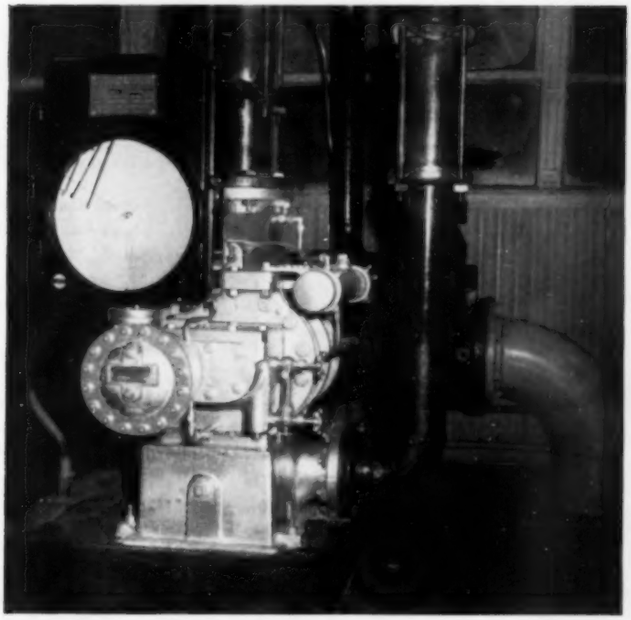


Photo No. 1848—R-C Meter with PVTT recorder measuring gas fuel input to engine on 3,000 HP generator unit in municipal plant.



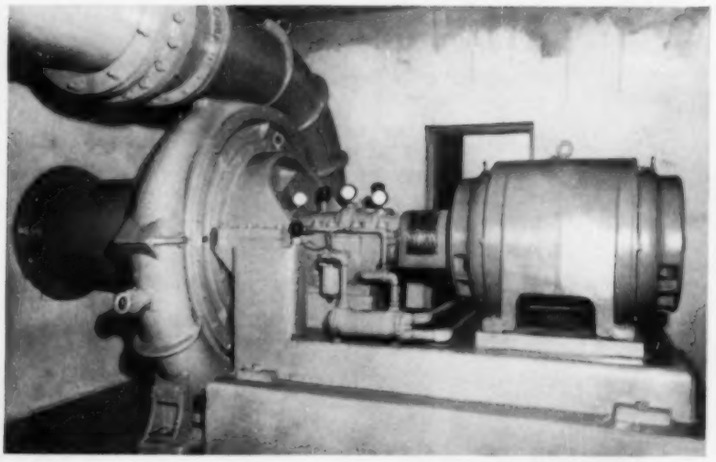


Photo No. H-312—R-C Single stage centrifugal blower type OIB for scavenging a 3500 HP engine. Blower rated 17,700 CFM 2.86 psi at 3600 RPM.

Photo No. 1611—R-C Rotary Positive Blower for supercharging Diesel engine. Capacity 575 CFM at 4 lbs. pressure at 3450 RPM.

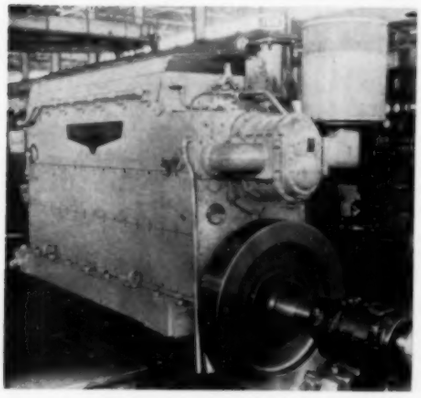
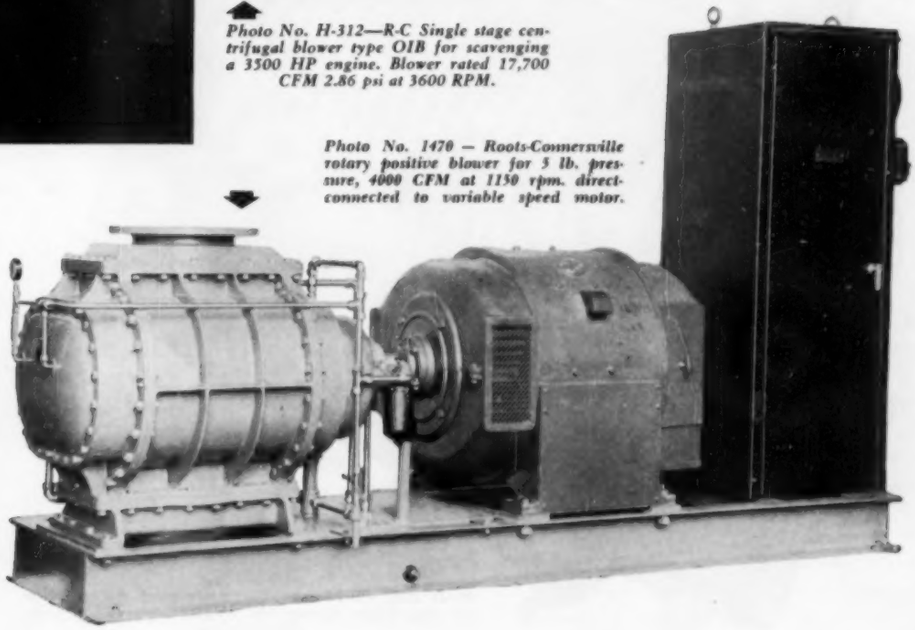


Photo No. 1470 — Roots-Connersville rotary positive blower for 5 lb. pressure, 4000 CFM at 1150 rpm. direct-connected to variable speed motor.



WADE ENGINEERING

WADE Roots-type superchargers are made in several standard sizes for industrial applications, and embody many special technical features that make them an attractive proposition where compressed air is required at pressures up to 10 p.s.i.g. (single stage) and 20/30 p.s.i.g. (multi-stage) with high mass flows.

In the oil-engine field, moreover, special designs are available for the pressure-charging of four-stroke, and the scavenging of two-stroke oil engines; but although these special designs differ from the standard range in size, ducting, and mounting arrangements, all embody the same advanced technical features experience has shown to be essential to the oil-engine designer. The following points particularly warrant attention.

(1) Experience has shown that the use of light-alloy rotors, cast or pinned or bonded on to a separate steel shaft, is a potential cause of unreliability, and expensive to produce. The rotors fitted to Wade superchargers are formed as to both rotor and shaft from light alloy extrusion.

(2) The ground-form steel gears commonly fitted to Roots-type superchargers tend to be noisy and are expensive to produce. All Wade superchargers are fitted with precision-cut steel and bronze helical gears. These are subjected to stringent noise-tests before delivery of a blower, and experience has proved that, given adequate lubrication, up to 20,000 hours' continuous running may be expected before replacement becomes necessary.

(3) On the two-stroke oil engines in particular, vacuum-governing must put heavy stress on the oil-sealing arrangements, and the ordinary lip-type oil seal is fundamentally unsuited to the Roots superchargers. All Wade superchargers are fitted with an 'air-gap' type of non-contact seal that is everlasting and absolutely efficient. Even under the most violent reversals of pressure, oil cannot reach the rotors.

(4) Efforts have been made in the past to obviate the noise inevitably associated with the Roots-type operating cycle, by fitting helical rotors—with the added cost and increased leakage-paths that this entails. All Wade superchargers incorporate the exclusive Helical Port, which —at no extra cost—reduces noise levels appreciably. Up to 30 per cent saving on air-silencer costs is possible with this feature.

(5) Standardization and quality production are the company's aim at its well-equipped factory at Brighton. Machining, inspection, and testing techniques are such that complete standardization of all parts is ensured, as well as the thermodynamic performance of every supercharger. The wide variation in performance—especially at high pressures and low rotational-speeds—so often experienced with unselected production superchargers is absolutely ruled out.

An illustration of a very miniature Wade supercharger (Type 3RA008) designed and produced for use on a liquid fuel starter. Approximate size 3x4x6".

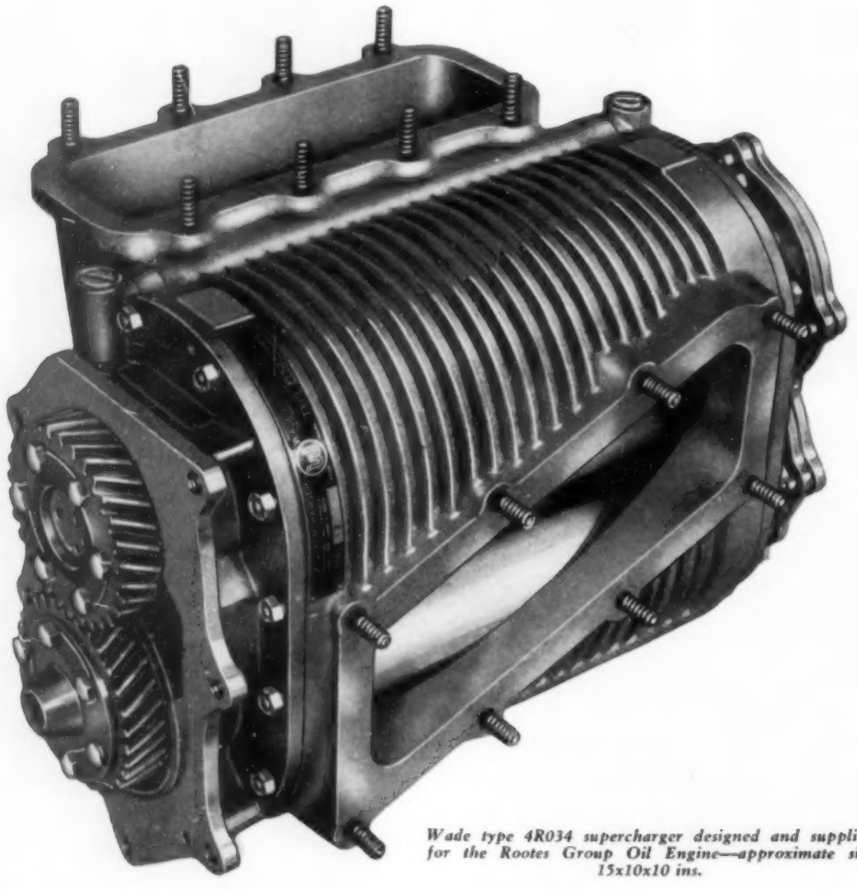
(6) The supercharger is so designed that a perfectly satisfactory reconditioned unit scheme can be operated where necessary.

(7) Design of the Wade supercharger, in conjunction with the manufacturing techniques adopted, makes it a highly economical unit to produce, and it is confidently claimed that the Wade super-charger provides the most attractive 'Additional Horse Power per/installed cost' ratio of all positively driven superchargers.

The advantages that result from supercharging an oil engine are now well known: higher power/weight, power/cost, and power/space ratios, smoother operation, better torque characteristics, and better altitude performance, with little, if any, penalty in fuel consumption—given an efficient supercharger. For the two-stroke engine, at present, the Roots supercharger is a 'must', so long as its basic price is sensibly related to the cost of engine production.

Some thousands of Wade superchargers are in service in many parts of the world. The company has had wide experience with the problems facing the oil engine manufacturer, and they welcome the closest cooperation at the initial stages of a new development.

Technical advancement however cannot stand still. Wade Engineering Ltd. whilst continuing its developments to produce an ever more efficient Roots supercharger at an ever more economic price, have been keeping very much 'alive' to the ultimate objective of being able to produce a turbo charger

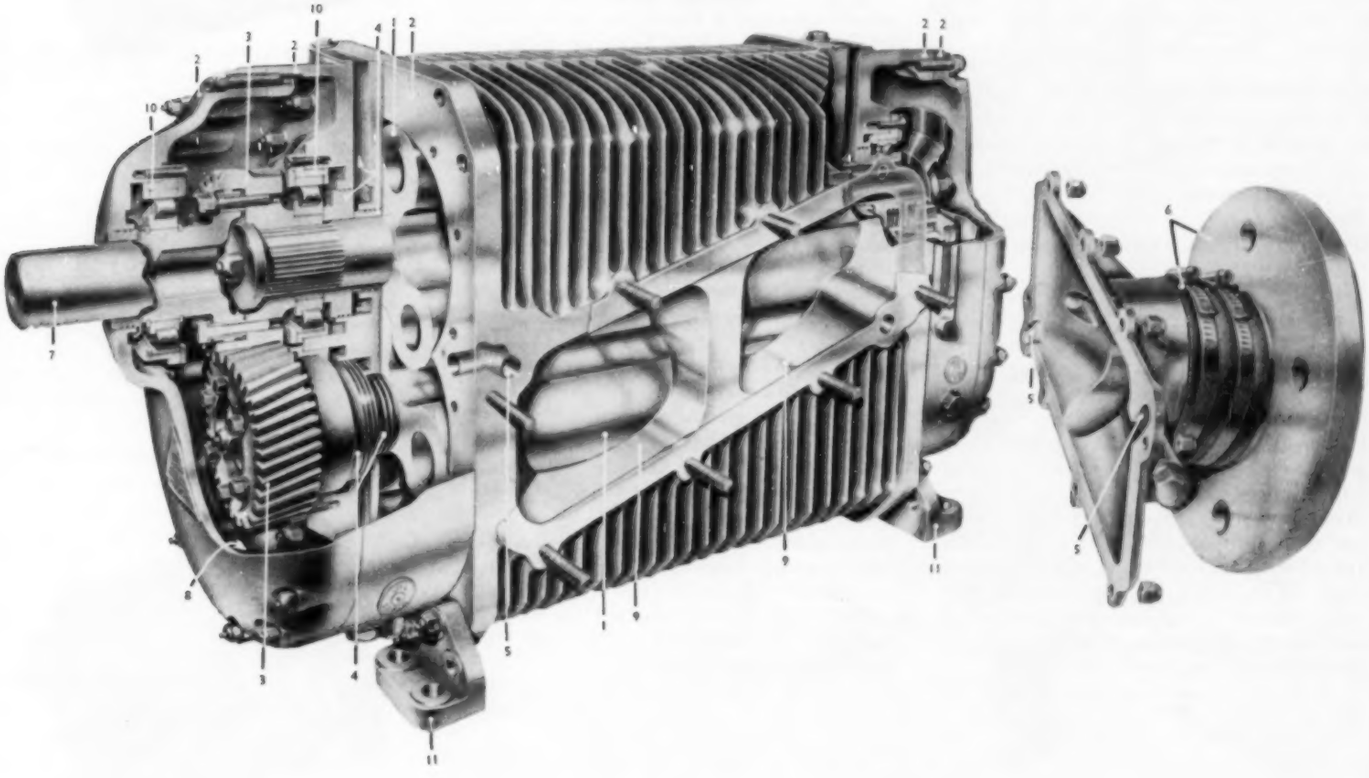


Wade type 4R034 supercharger designed and supplied for the Rootes Group Oil Engine—approximate size 15x10x10 ins.

POSITIVE DISPLACEMENT ROOTS-TYPE SUPERCHARGERS

which on comparative price to performance could be put forward as a distinct improvement on the Roots supercharger for those many applications where supercharging of engines of 150 H.P. or less is desired. Their development department have been actively engaged on research into this problem for some years, and although the difficulties inherent in their approach to the problem have taken much longer to solve than was earlier hoped for, they are very confident of being able to offer before the end of this year their advanced contribution to this turbo charging field.

Sectional drawing to illustrate the salient features of a standard Wade supercharger (Type 4R060).



THE SALIENT FEATURES NUMBERED ON THE ABOVE SECTIONAL DRAWING ILLUSTRATED ARE:

1. ROTORS—Special three lobe rotor shape to obtain maximum operating effciency.

2. CASTINGS—Made in aluminum alloy, castings comprise a case, front and rear housings, and front and rear covers.

3. GEARS—Of a steel and bronze combination for long operating life, the helical teeth combined with specialist manufacturing technique, ensures the maximum of quietness in operation.

4. OIL SEALS—A combination of two labyrinth seals with an air gap in the housings, which has the effect of completely overcoming the sealing problems generally associated with Roots blowers, and in particular completely overcomes the vacuum governing problems on oil engine applications. There are no sliding contacts and nothing to wear out.

5. BY-PASS—This allows the air gaps to be used without modification for operating fluids other than air.

6. DUCTS.

7. DRIVE EXTENSION SHAFT—Made in steel.

8. OIL SUMPS.

9. PORTS—The ports are helical which has the effect of obtaining the maximum of quietness in operation, and achieves the technical advantage of the helical rotor without extra cost.

10. BEARING CARRIERS—These are in steel to prevent the loosening of the bearing in aluminum under high temperature.

11. UNIVERSAL MOUNTING—So designed to be quickly adaptable to various mounting positions.

GODFREY

POSITIVE DISPLACEMENT SUPERCHARGERS

SIR George Godfrey & Partners (Industrial) Ltd., of Hanworth, Middlesex, England, have been manufacturing positive displacement superchargers for twenty years. Operating on the Roots principle, these machines have proved eminently suitable for supercharging and scavenging four cycle and two cycle oil and petrol engines. Another important application of the superchargers is in the recovery of power on engines operating at high altitudes.

The machines are inherently simple, they take little space and are therefore easy to install. Typical examples of the neat installations resulting from these features are shown in the illustrations of the Swedish Penta Model KMD 96 and the Rolls Royce C 6 SFLM. Another advantage of the Godfrey supercharger is its relatively low cost.

Standard models in production can deliver up to 3,500 cfm of air at pressures up to 10 psi; these flows and pressures can, of course, be increased with multiple installations.

All superchargers in the Godfrey range are basically similar, each consisting of two parallel rotors geared together to rotate in opposite directions in a rotor chamber. The rotor chamber is formed by a rotor case and two end plates, or covers; the rotor case has an air inlet port and an air outlet port and the end plates house the bearings for the rotor shafts. On the ends of the two rotor shafts that project through the drive end plate, two gears are mounted; the setting of these gears determines the clearance between the rotors.

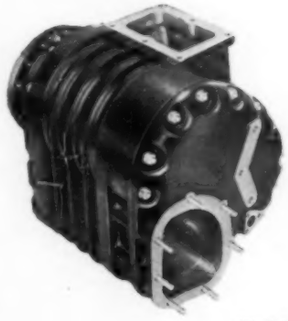
The only parts of the machine requiring lubrication are the gears and bearings; oil for this purpose is usually obtained from the low pressure side of the engine lubrication system. Seals fitted to the ends of the rotor shaft prevent oil entering the rotor chamber and ensure clean air delivery. The operating principle of this type of machine is similar to a gear pump except that there is no contact between the rotors or between the rotors and the rotor chamber. Air is drawn by the rotors into the rotor chamber and discharged through the outlet port by the intermeshing action of the rotors.

The volume of air delivered is approximately proportional to the speed of the rotors. By operating their machines at high rotor speeds, the Company has been able to produce comparatively small machines capable of handling large flows. Another advantage of operating at high rotor speeds is that efficiency has been improved by reducing the proportion of slip losses to the volume of air delivered.

Godfrey superchargers are today operating throughout the world and are currently in production for all supercharged versions of the Rolls-Royce "C" range of oil engines; they are also supplied to Fiat of Italy, Penta of Sweden and many other British manufacturers of oil engines.

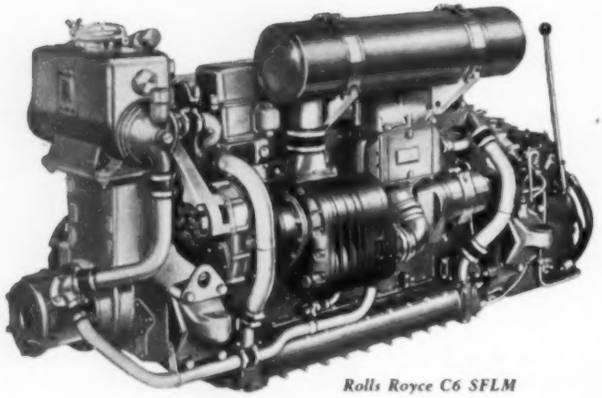
Engine manufacturers are invited to present their supercharging problems to the Company which has available at the Hanworth plant substantial facilities for technical investigation and test. Affiliated Companies are established in Montreal, Melbourne and Johannesburg.

Model M2000

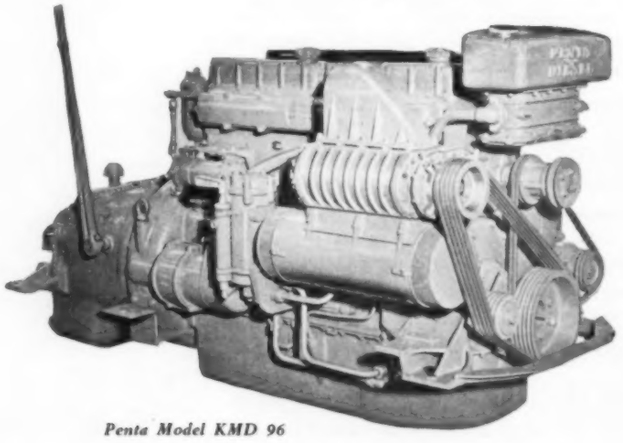


Model L450

Model K200



Rolls Royce C6 SFLM



Penta Model KMD 96

BOSCH
GERMANY

FUEL INJECTION EQUIPMENT

THE firm of Robert Bosch G.m.b.H. in Stuttgart, Germany, manufactures a complete line of fuel injection equipment and related accessories for the entire range of diesel engines produced anywhere in the world. The Company importantly pioneered diesel fuel injection, commencing over thirty years ago. Its accomplishments were of major significance from the outset and soon set the standards of quality and precision for this equipment which made the high speed diesel practical. Consequently the Bosch type of injection system has become well known in all countries, and the products of Bosch-Germany are marketed and serviced throughout the world.

The line of fuel injection products comprises injection pumps and nozzles in a wide variety of types and sizes, also innumerable accessories such as fuel supply pumps, governors, manual and automatic timing devices, filters, service tools, pump calibrating stands, nozzle testers and many others.

INJECTION PUMPS—All injection pumps manufactured by Robert Bosch employ the time-proven principle of high pressure metering, with constant stroke plungers operating in barrels having intake ports and spill ports. The pumps are available in two basic styles, the type PE, with integral camshaft for plunger actuation, and the type PF, for plunger actuation by cams provided within the engine structure. In these types the major working parts, such as the helix-metering plunger-barrel assemblies, the delivery valves, etc., are identical and each plunger and barrel assembly with its associated parts forms an individual pumping unit serving one engine cylinder. The PE and PF styles of pump are both available for engines of small and medium size. Only the PF style is available for the largest engines, however. The following tables show the pump size designations and the respective size characteristics:

For the PE Line

Size Designation	M	A	B	BB	Z
Cam Lift in mm.	7	8	10	10	12
Smallest Plunger (diameter in mm.)	4	4	5	5	10
Largest Plunger (diameter in mm.)	8	9	10	12	16

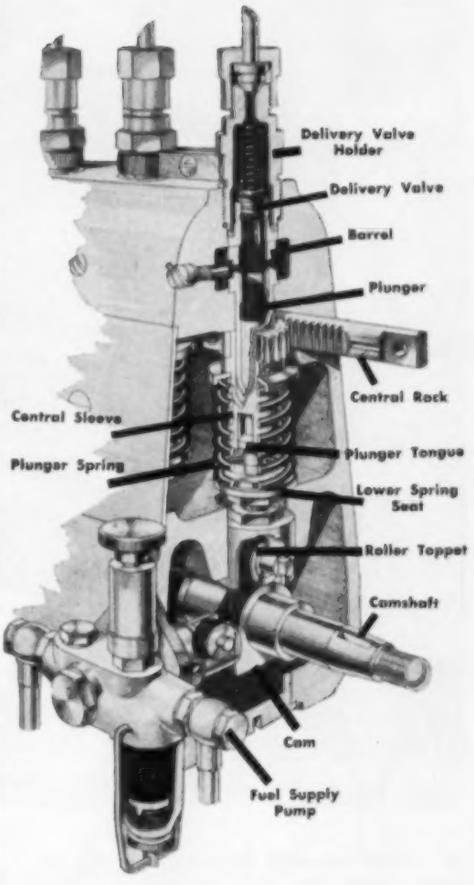
The PE types referred to above combine from 1 to 8 pumping elements in one pump assembly.

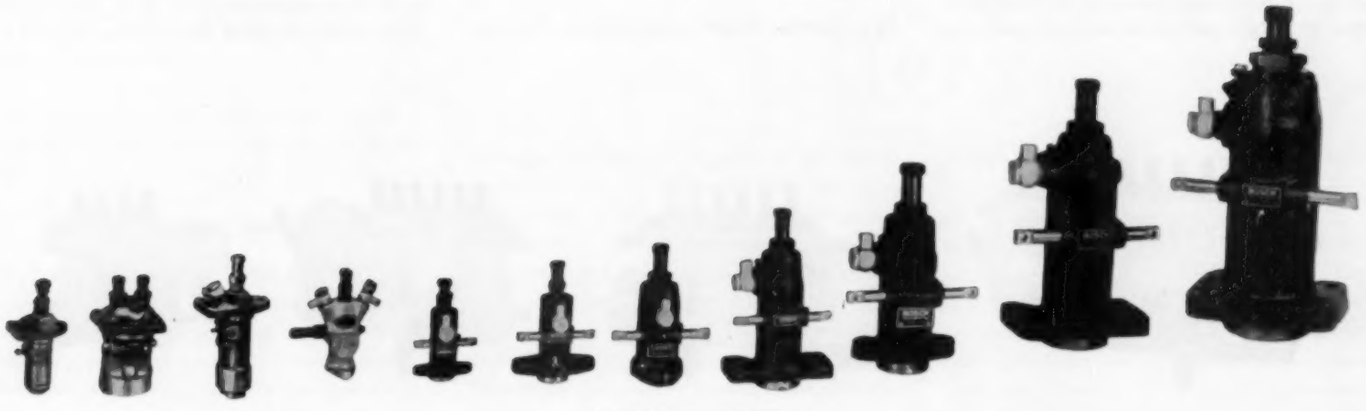
For the PF Line

Size Designation	M	A	B	Z	C	W	D	E
Cam Lift in mm.	7	8	10	12	15	20	30	35
Smallest Plunger (diameter in mm.)	4	4	5	10	10	15	14	20
Largest Plunger (diameter in mm.)	8	9	10	16	18	22	22	30

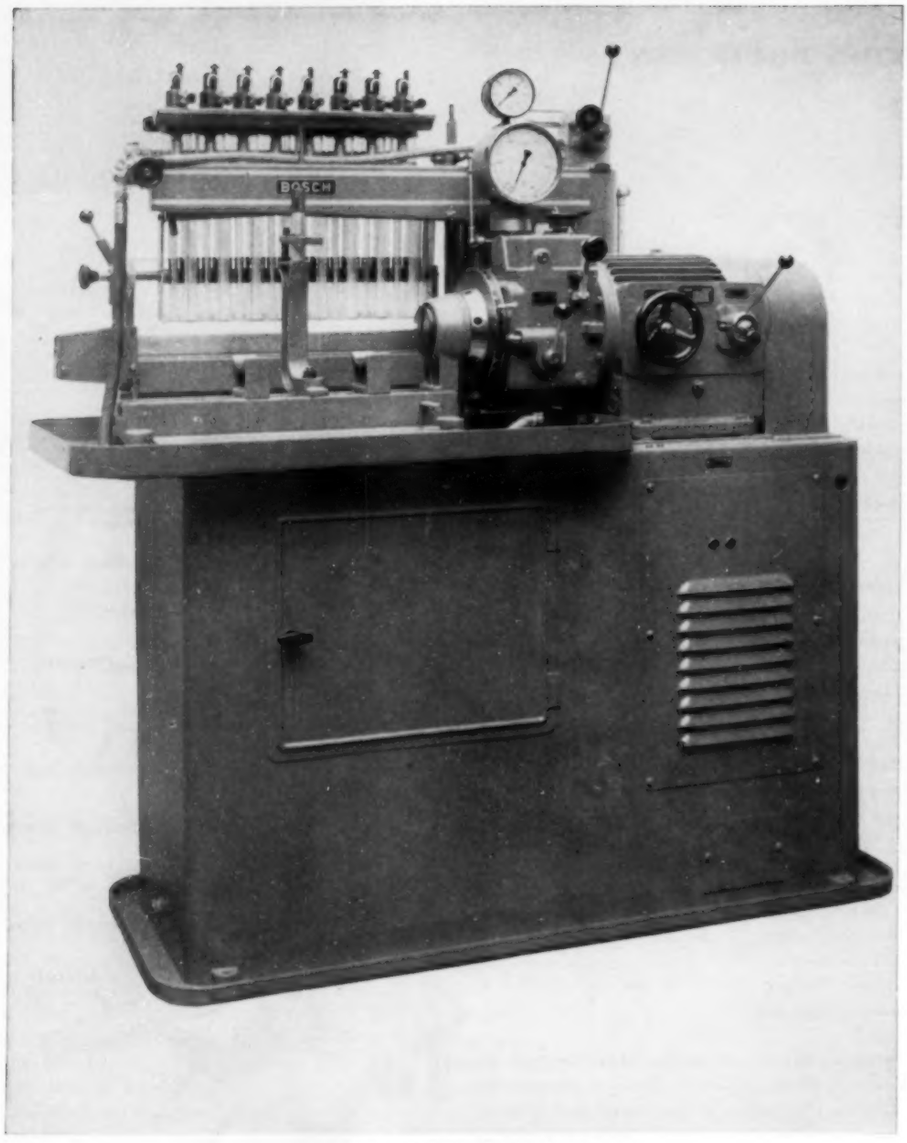
Mounting flange configurations of various types are available for the PF pumps referred to above, as are different orientations of the control rack with respect to the mounting flange. Cams for actuating these PF pumps must be provided within the engine structure.

For the PE injection pumps, a variety of camshafts





Line of PF type pumps.



EFEP 5A Calibrating stand.

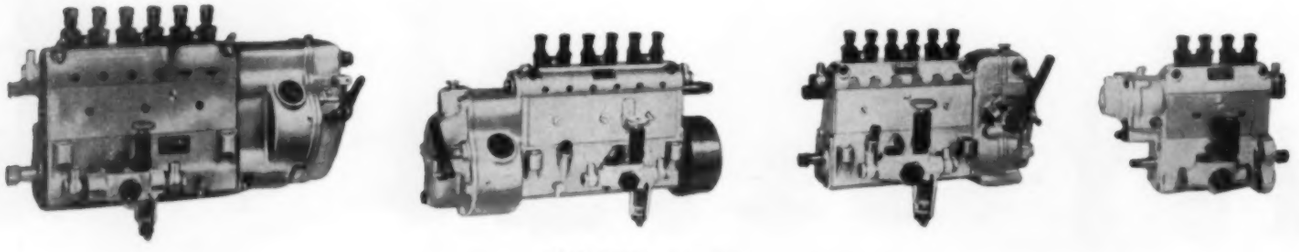
are available providing different cam profiles for different plunger lift curves, also different cam arrangements to suit the various engine firing orders. These pumps can be had in either base-mounted or flange-mounted executions. Governors, fuel supply pumps and timing devices may be attached to form an integral part of the injection pump assembly, removable from the engine as a unit for servicing. Similarly the lesser accessories such as drive couplings, overflow valves, fixed or variable metering rack stops, angle discharge fittings, etc. become integral components of the whole unit.

FUEL SUPPLY PUMPS are manufactured to draw the fuel from the supply tank and transfer it to the injection pump under moderate pressure. These supply pumps are designed for direct attachment to PE type injection pumps and are themselves of the cam-actuated plunger type, providing adequate suction lift from fuel tanks and the high primary fuel pressure desirable for high speed injection systems. They are produced in two plunger sizes and in single- as well as double-acting executions so as to meet the requirements of the entire range of PE-type injection pumps. They can be obtained with or without positive hand primer and with or without prefilter.

GOVERNORS designed for installation on PE-type injection pumps are either of the pneumatic or the mechanical type. The pneumatic governor is an inexpensive device particularly suitable for small high-speed engines not requiring close regulation in the upper speed range, while the mechanical governor is recommended where close regulation throughout the entire speed range is required, or where it is desired to control only the low idle and over-speed conditions, as is sometimes the preference in automotive service. A special feature of Bosch-Germany mechanical governors is that the force which must be exerted on the operating lever in order to effect a speed change is very small under all operating conditions. Other unique design features ensure adequate force amplification at low speeds so that excellent regulation of idle speed is obtained. The mechanical governors are also available in executions which automatically give excess fuel for starting and automatically provide engine torque control, by varying the maximum pump delivery in accordance with a predetermined relationship with speed, either to insure smoke-free operation throughout the speed range or to give the engine the torque characteristics required by specific applications.

TIMING DEVICES for altering the timing of injection while the engine is in operation are available in two types, the manually adjustable and the type which automatically varies injection timing in response to speed changes. The latter type, available only for the three smaller sizes of PE pumps, is of novel design. Both compact and durable, it permits on certain engines a considerable performance improvement.

NOZZLES—Bosch-Germany originated many of the nozzle designs which are in broad usage today. A great variety of sizes and executions can be supplied to suit the requirements of any engine. The various diesel nozzles are all of the type that have differ-

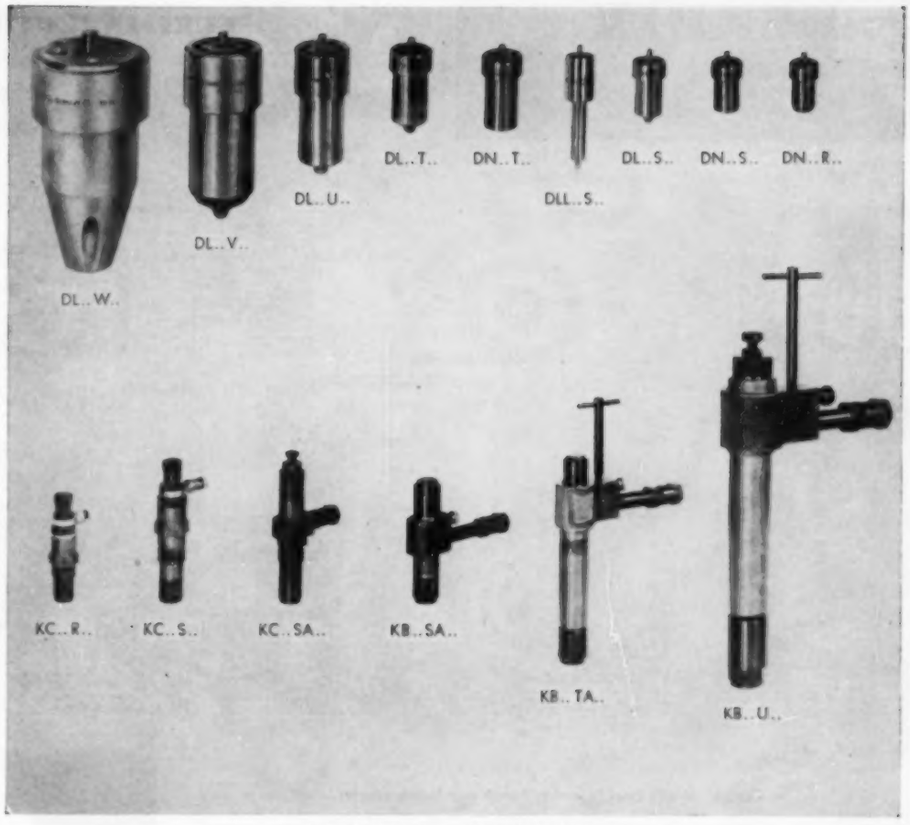


Typical PE type pumps.

ential needle valves, inwardly opening. They are classed as of the plain hole type or the pintle type. the hole type nozzle ordinarily has multiple spray orifices, suited to a specific combustion chamber, and can be supplied for engines of any size; it may also be had with liquid cooling where engine design or operating conditions necessitate this.

Pintle type nozzles are made in three basic sizes for use in high-speed engines having precombustion, turbulence, energy-cell or similar combustion chambers. In each size the pintles are furnished in many different shapes and dimensions. An important variation of the pintle nozzle is the so-called throttling pintle nozzle, designed to permit a small quantity of fuel to be injected in especially well atomized form ahead of the main injection. This preinjection has been found advantageous in many engines to obtain the desired smoothness of combustion, particularly when fuels of low ignition quality are being burned.

NOZZLE HOLDERS—in a great variety of types and sizes are manufactured by Bosch-Germany. The extensive line accommodates all available nozzles while meeting also the requirements of many engine designs. Thus numerous models are being produced with different shank lengths, different shank diameters, different locations of fuel connection, etc., and there is provision for different methods of anchorage in cylinder heads. Most nozzle holders are designed to be held in place by studs through a bridge or flange, but screw-in holders are also available in the smaller sizes, allowing a particularly economical method of nozzle installation.



Injection Nozzles and Nozzle Holders.

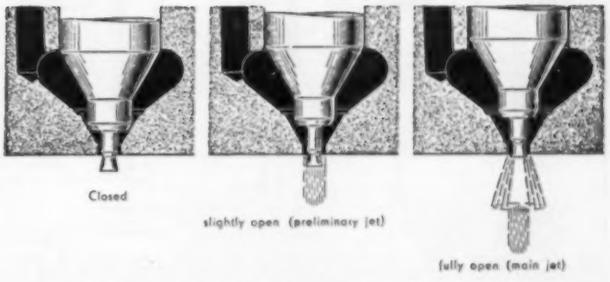
Filters

Robert Bosch have always supplied fuel filters designed specifically for the protection of fuel injection equipment.

The Bosch-Germany Duo-Filter is a combination of the cell filter and the felt tube filter, but with further important features.

The Duo-Filter consists of an ante-filter and a fine filter in two separate housings connected in series. The felt tube ante-filter which can be cleaned frequently keeps the coarser impurities in the fuel away from the fine filter, thereby insuring that the latter can function without fouling over a long period of time. This is tantamount to a guarantee that only super-filtered fuel reaches the injection system. The housing of the fine filter may be protected against unnecessary and unauthorized interference by lead-sealing.

The filters are produced in several sizes, all of them designed to remove particles down to one micron size.



Throttling pintle type nozzle.

Calibration Stands

In addition to a complete line of service tools including nozzle testers, maximum line pressure measuring devices, swaging tools for cold-forming integral nipples on high pressure fuel lines, and other items, Bosch-Germany produces a line of universal injection system calibration stands for balancing the output of the individual pumping elements of injection pumps, for adjusting the speed and torque characteristics of governors, and for checking the performance of injection pump assemblies generally, including fuel supply pumps and timing devices. These test stands can accommodate PE pumps of all sizes and in up to 8 cylinders. Special fixtures are available for testing the smaller sizes of PF pumps. The stands are powered by 5 hp motors which drive the pumps through an infinitely variable gear. A step-up gear attachment for obtaining unusually high speeds is an available extra.

A special model of test stand is manufactured for testing the larger sizes of PF-type pumps. This model is supplied with pump mounting and drive assemblies containing the cam and tappet mechanisms required for actuation of PF units in the various larger sizes. Other makes of injection pumps may also be tested on this stand.

BENDIX

FUEL INJECTION EQUIPMENT

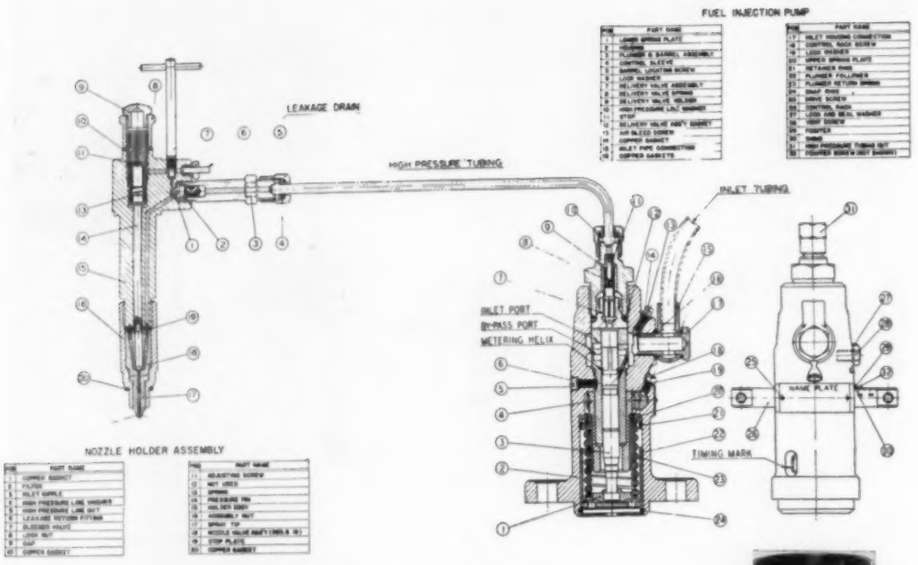


Fig. 1.
Typical Bendix Fuel Injection Pump and Nozzle Holder.

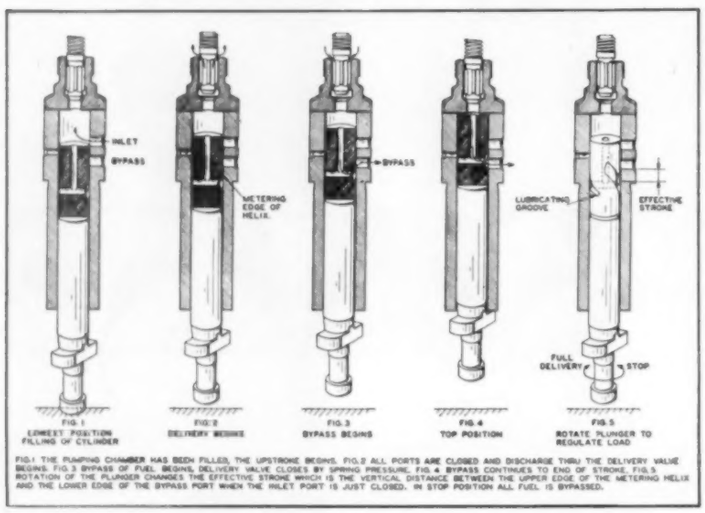


FIG. 1 THE PUMPING CHAMBER HAS BEEN FILLED, THE UPSTROKE BEGINS. FIG. 2 ALL PORTS ARE CLOSED AND DISCHARGE THRU THE DELIVERY VALVE BEGINS. FIG. 3 BYPASS OF FUEL BEGINS, DELIVERY VALVE CLOSES BY SPRING PRESSURE. FIG. 4 BYPASS CONTINUES TO END OF STROKE. FIG. 5. ROTATION OF THE PLUNGER CHANGES THE EFFECTIVE STROKE WHICH IS THE VERTICAL DISTANCE BETWEEN THE UPPER EDGE OF THE METERING HELIX AND THE LOWER EDGE OF THE BYPASS PORT WHEN THE INLET PORT IS JUST CLOSED. IN STOP POSITION ALL FUEL IS BYPASSED.

Cut-away of liquid cooled nozzle and spray tip.

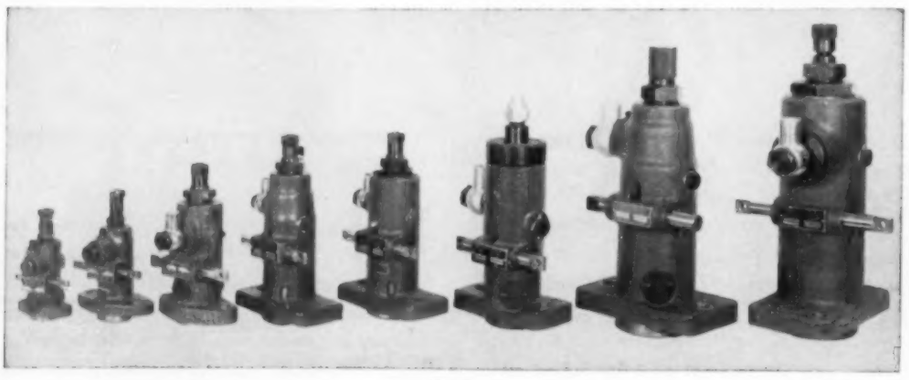


Fig. 2.
Fuel Pumps Types FA, FB, FBC, FC, FCX, FCD, FD, and FDRX.

SCINTILLA Division, Bendix Aviation Corporation manufactures at Sidney, New York, a complete range of individual cylinder fuel injection equipment for Diesel engines of from approximately 4" to 20" bore. This equipment is used by numerous manufacturers of Diesel engines on their product.

Injection pumps are of the port controlled plunger type, the fuel quantity being controlled by a helical by-pass edge in the plunger surface, which is rotated by means of a gear and control rack. Special features include long sealing surface on the upper end of the plunger above the metering helix, a helical lubricating groove opposite the metering helix of the plunger and proper balancing of the plunger to reduce wear from side pressure and to maintain a good seal at the ports over long periods of operation.

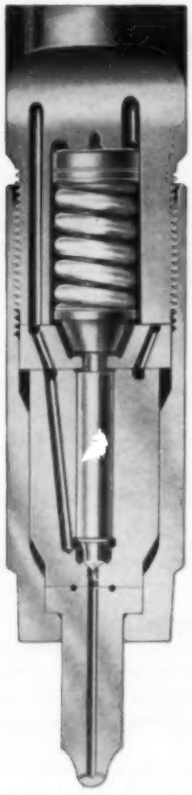
Fig. 1 shows the construction of a typical pump and nozzle holder assembly. Fig. 2 shows the pumping cycle. These pumps are manufactured in 8 housing sizes, the type designation and characteristics being as shown in the following table:

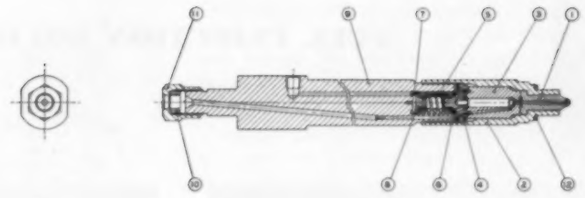
Basic Type	Maximum Plunger Stroke	Plunger Diameter
FA	7 MM	5- 9 MM
FB	10 "	6-11 "
FBC	12 "	11-15 "
FC	15 "	10-18 "
FCX	15 "	17-20 "
FCD	23 "	18-24 "
FD	30 "	18-24 "
FDX	30 "	24-30 "

The letter "R" when added to the type designation shows that the control rack is located at right angles to the mounting flange. The letter "X" in the type designation indicates heavy duty construction.

Nozzles and nozzle holders are made in a wide range to suit engine sizes and designs. Lengths of shank vary from 2" to 14" in length. Each nozzle holder assembly consists of a heavy holder with inlet and drain fittings, filter, vent screw, nozzle valve, nozzle spring with means of adjustment and a spray tip having orifices to suit the combustion chamber of the desired engine performance. Nozzle valves are of the differential type, hydraulically operated. The combination of a differential nozzle valve and separate spray tip permits very satisfactory operation to be obtained and sticking of the valve needle from excessive temperature does not occur.

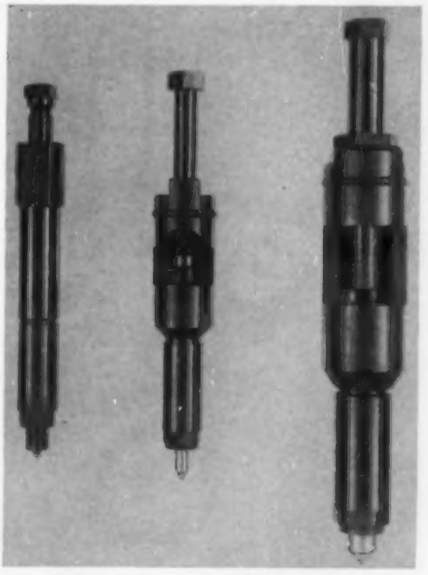
For large engines, using heavy, preheated fuels, type HDW nozzle holders are provided with passages for the circulation of cooling fluid (fresh water or oil) through the nozzle valve and spray tip. Several types of cooled spray tips are provided.





Section of type HCL nozzle holder assembly.

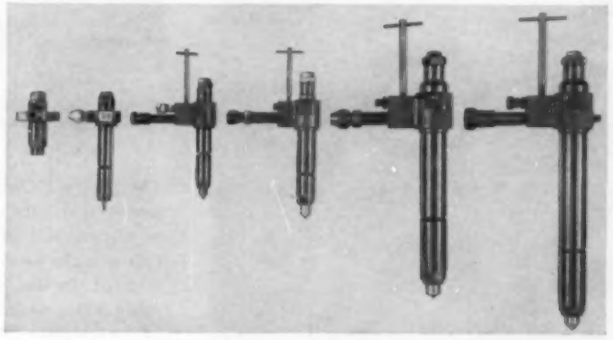
1. Spray Tip
2. Assembly Nut
3. Nozzle Valve Assembly
4. Stop Plate
5. Spring
6. Spring Button
7. Shims
8. Spring Seat
9. Body Holder
10. High Pressure Line Washer
11. High Pressure Line Nut
12. Copper Gasket



Three special nozzle holders, types HCL-175, HNO-C, and HNO-DW.

Section of type HCL nozzle holder assembly.

Nozzle holder assemblies, types HBF-35, HBV-100, HB-125, HCV-150, HDV-250, HDW-300.



BENDIX UNIT INJECTORS

Bendix Unit Injectors combine the functions of fuel injection pumps and injectors in a single unit, which meters the fuel and injects it into the combustion chamber. The high pressure line between pump and injector is eliminated.

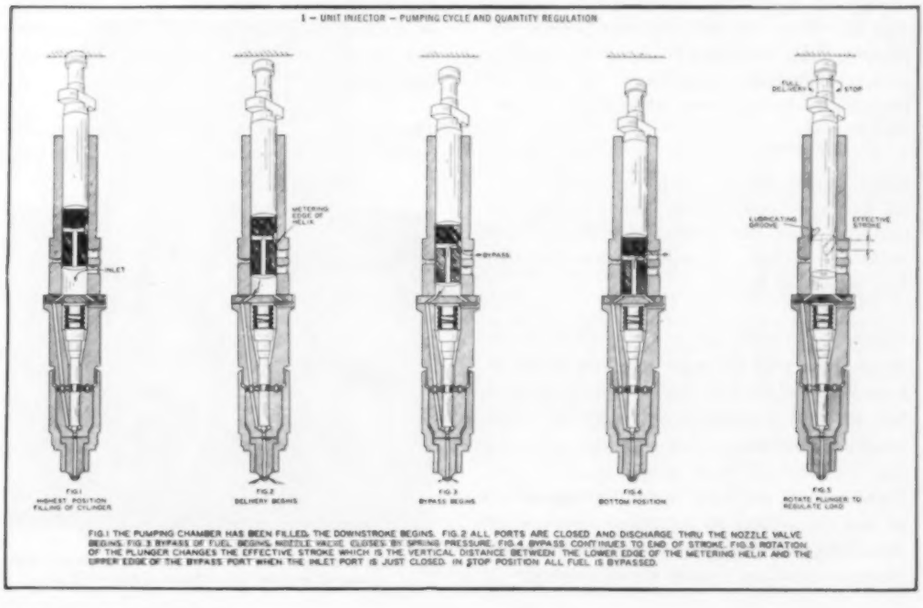
The Unit Injectors are manufactured in various sizes as indicated below:

Type	Maximum Stroke	Plunger Diameters	Maximum fuel Quantity per Stroke
UB	10 MM	9-11 MM	300 cu. MM.
UC	15 "	12-17 "	1500 cu. "
UCX	15 "	18-20 "	2100 cu. "

The Unit Injector is installed in a cavity in the cylinder head and is seated on a copper gasket. It is held on its seat by a clamp and positioned by a dowel pin to maintain perfect alignment of the control rack with the governor control mechanism of the engine. The plunger follower and plunger are reciprocated by the engine fuel cam and rocker arm.

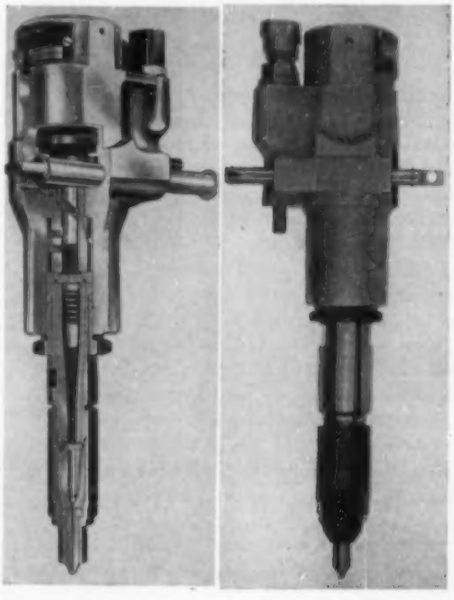
Fuel enters the injector through a fitting and filter, fills the space surrounding the ported end of the barrel and enters the pumping chamber through the inlet port, continuous circulation of fuel is maintained while the engine is in operation.

The accompanying diagram shows the pumping cycle and method of fuel regulation. (Form L-110-1.) Photographs illustrate Type UB and a view of a cut-away Type UC.


1 — UNIT INJECTOR — PUMPING CYCLE AND QUANTITY REGULATION
INLET
METERING EDGE OF HELIX
BYPASS
FUEL DELIVERY
STOP
LUBRICATING GROOVE
EFFECTIVE STROKE
FIG.1 HIGHEST POSITION FILLING OF CYLINDER
FIG.2 DELIVERY BEGINS
FIG.3 BYPASS BEGINS
FIG.4 BOTTOM POSITION
FIG.5 ROTATE PLUNGER TO REGULATE LOAD
FIG.1 THE PUMPING CHAMBER HAS BEEN FILLED. THE DOWNSTROKE BEGINS. FIG.2 ALL PORTS ARE CLOSED AND DISCHARGE THRU THE NOZZLE VALVE BEGINS. FIG.3 BYPASS OF FUEL BEGINS, NOZZLE VALVE CLOSES BY SPRING PRESSURE. FIG.4 BYPASS CONTINUES TO END OF STROKE. FIG.5 ROTATION OF THE PLUNGER CHANGES THE EFFECTIVE STROKE WHICH IS THE VERTICAL DISTANCE BETWEEN THE LOWER EDGE OF THE METERING HELIX AND THE UPPER EDGE OF THE BYPASS PORT WHEN THE INLET PORT IS JUST CLOSED. IN STOP POSITION ALL FUEL IS BYPASSED.

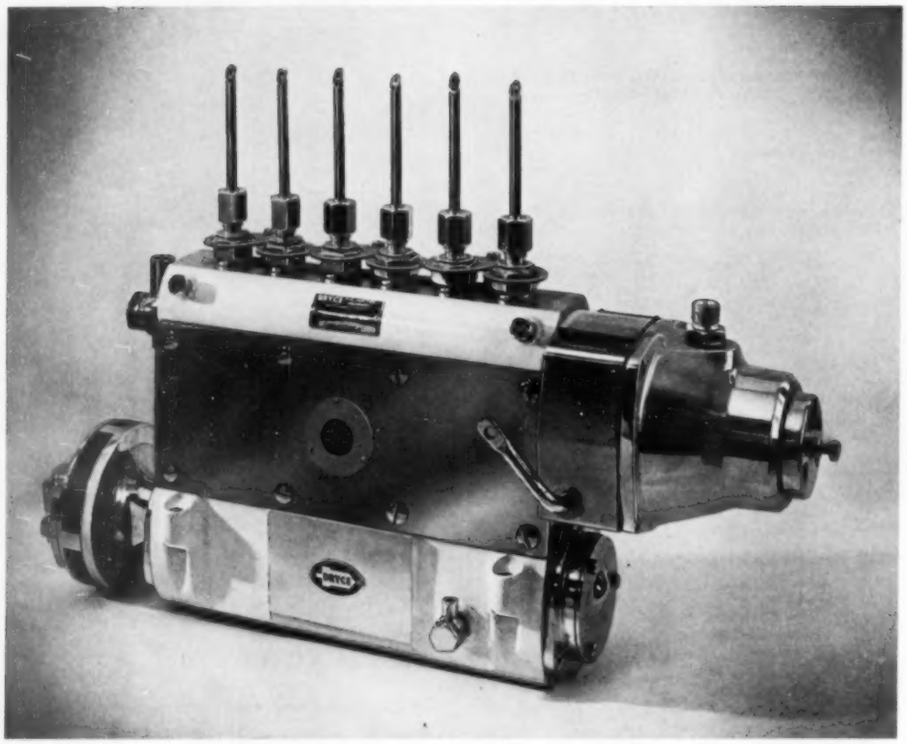
Sectionalized view of Type UC Unit Injector.

Bendix Unit Injector, Type UB.



BRYCE

FUEL INJECTION EQUIPMENT



A Bryce six cylinder 'A' size Camshaft Pump, fitted with the recently introduced pneumatic Governor.

THE latest range of Bryce Fuel Injection Eqiupment covers the needs of a wide variety of diesel engines of all powers up to 250 bhp per cylinder. The range includes injection pumps, nozzle holders, nozzles, as well as centrifugal and pneumatic governors. The standards of design and manufacture are the highest, and the distribution of this equipment is backed by a network of fully qualified service agents in over ninety countries throughout the world. The products of the Company include a range of A and B size multi-cylinder camshaft pumps; these have been designed to fill the need for robust and simple units for multi-cylinder engines requiring single enclosed pumps with integral camshafts, in preference to individual pumps for each cylinder. The well-proved features of the Bryce flange-mounted pumps have been incorporated, whilst the additional components are of sound design and sturdy construction providing an extremely reliable unit of the highest possible accuracy. Like the Bryce flange-mounted pumps, the new camshaft pumps operate on the constant stroke variable spill principle, utilizing a ground helix to give the required spill control. The area of metal removed in machining is held to the minimum that will permit the unrestricted passage of the spilled fuel, thus giving the maximum bearing surface at this vital point.

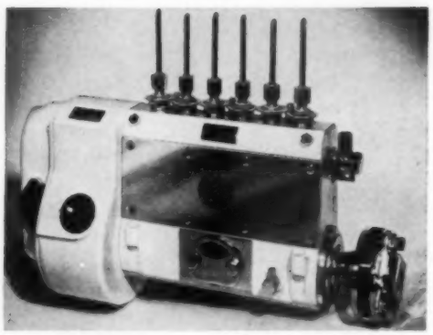
The pump is housed in a monobloc aluminium die-casting, for greater strength and rigidity. The large front opening is enclosed by a cast inspection cover carrying the air filter, breather, and lubricating oil filler plug. An upward extension covers and seals the sleeve-locating screw heads, overcoming any tendency for leakage.

The camshaft is carried on roller bearings of ample load-carrying capacity which contribute to long life, whilst the shaft diameter permits full pumping loads without deflection and eliminates torsional vibration. Spring-loaded oil seals are pressed into the end covers which carry the camshaft bearings.

Roller tappets, having a generous guided length, are located by dowel screws passing through the pump housing; this permits easy renewal and avoids the necessity for replacing housings after long periods of service.

Tappet adjustments for pump phasing are by means of fine-pitch screws and lock nuts, giving the finest degree of accuracy. Calibration devices have been designed to ensure accurate adjustment without fear of damage.

Locking plates are fitted to the discharge unions so that the initially set controlled torque is not disturbed by the fitting of high-pressure feed pipes. Generous provision is made for air venting.



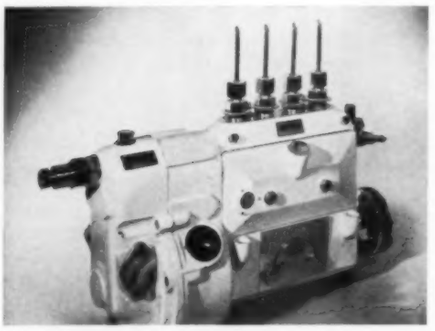
A Bryce six cylinder 'A' size Camshaft Pump with maximum/minimum speed centrifugal Governor.

The pumps conform to standard installation dimensions, and are suitable for two to six cylinders, or may be coupled for eight or twelve cylinders. Left or right hand rack operation is available as required. In the 'A' size, a monobloc 8 cylinder pump is now available.

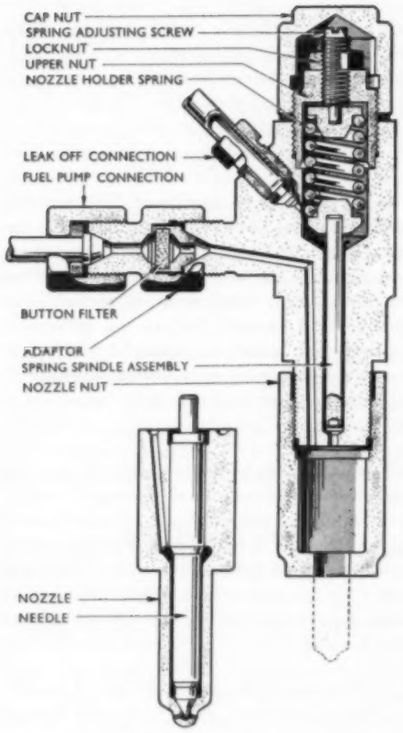
Centrifugal governors of conventional design are available, with idling to maximum engine speeds ranging from 350 to 2,000 rpm on four stroke engines. The governor can be mounted on either end of the pump.

Pneumatic governors are available for 'A' size camshaft pumps, the units being capable of controlling engine speeds at any value between the maximum and idling speeds, which are predetermined by adjustable stops. These governors are therefore eminently suitable for commercial vehicle applications and also for industrial and marine engine use. The two main portions of the unit are the venturi air flow control unit, mounted in the induction pipe between the air filter and the engine, and the pressure sensing unit which is mounted on the fuel pump and operates the fuel control rack. These two parts are connected by an air-tight tube.

The operation of the governor is based upon the well-known principle that air velocity across the



A Bryce four cylinder 'B' size Camshaft Pump with variable speed centrifugal Governor.



The construction of a typical Bryce nozzle and nozzle holder.

end of a tube will tend to cause a pressure drop in that tube. In this case, the air velocity to the engine across the top of the tube is controlled by a butterfly valve in the venturi unit, and the pressure drop set up in the tube is transmitted to the governor casing. The volumetric efficiency of the engine is not changed by the presence of the venturi unit.

The governor casing is divided into two halves by a leather diaphragm, specially treated and prepared to render it extremely pliable. One half forms an air-tight chamber (with the exception of the tube connection to the venturi) but the other half is open to atmospheric pressure. A light spring acts on the diaphragm, loading the fuel control rack towards full fuel position, and the balance point of the diaphragm under the action of the spring load and depression on one side, and the atmospheric pressure on the other, locates the fuel pump rack so as to deliver the required amount of fuel to the engine. In its operation, the spring also damps out high frequency pressure variations, thus contributing to a smooth response. In order to stop the engine, a lever is provided which can over-ride the spring and move the fuel control rack to the stop position; a small auxiliary spring is also housed in the governor casing to provide the necessary engine idling performance.

The engine speed is controlled within its limits by the lever operating the butterfly valve, which may be actuated by an accelerator pedal or other appropriate mechanism.

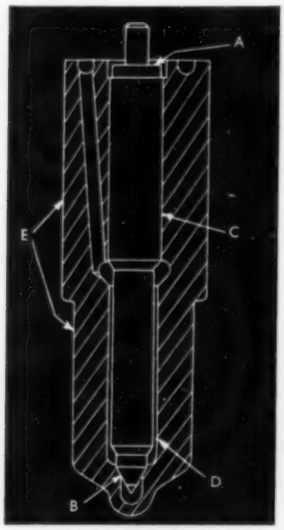


Diagram showing the construction of the Bryce HLT nozzle, for use in higher rated engines.

A Bryce flange-mounted 'A' size pump, the rack of which is fitted with the new dust excluding bellows.

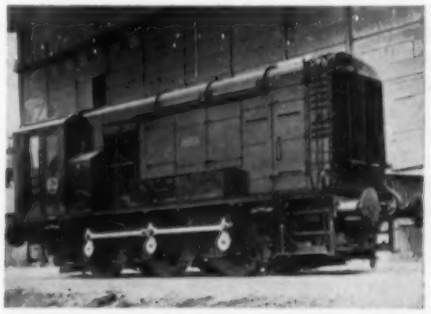
Bryce Berger Limited are continuing to produce their range of single cylinder flange mounted pumps, in A, B, Z, C, X and D sizes, incorporating a wide variety of plunger diameters and stroke lengths to cover all applications. Of particular note is the inclusion of D size pumps with 24 and 26 mm. plunger diameters.

Hole type nozzles are produced in S, T, U and V sizes and pintle types in S and T sizes. Long stem Size nozzles have been available for some time for automotive uses, and to these have been added recently long stem nozzles in HL-T and HL-U sizes.

The development of the larger high-speed direct injection engine has led to a situation where it becomes necessary to provide generous flow passages to ensure that the energy imparted to the fuel is not lost before delivery through the injection holes to the combustion chamber. In addition, the increased fuel quantities required, together with the higher injection rates, have made conditions more severe, whilst cooling problems become more and more acute.

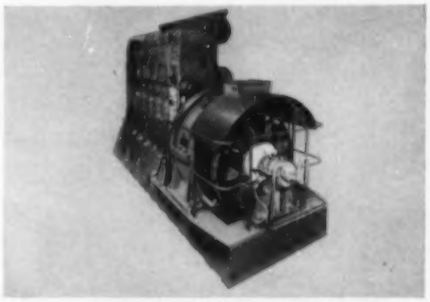
After great study of the problems of capacity and delivery speed, Bryce Berger Limited has developed the HL-T nozzle, as the practical solution. The larger diameter needle (A), with increased seat diameter (B) gives bigger areas of seat and thrust shoulder (to resist impact loads), and allows the use of a larger diameter tunnel, thus eliminating restrictions of flow. The lapped portion of the needle (C) is at a considerable distance from the heat centre and is located in that part of the body which is most free from distortion. The large area of needle, fully surrounded by fuel (D), ensures that this obtains the maximum cooling. These internal changes have been achieved without increase in the space required to accommodate the injector in the cylinder head (E).

Extended running trials on various engines have shown that this design is fully worthy of its inclusion in the Bryce range, and it has been found to increase considerably the life of nozzles used for these higher-rated engines.



An English Electric diesel-electric shunting locomotive as supplied to Imperial Chemical Industries Ltd. The engine is fitted with Bryce fuel injection equipment.

A mobile generating set embodying the National M4A3 diesel engine, supplied to the Government of Bombay Electric Grid Department, and fitted with Bryce fuel injection equipment.

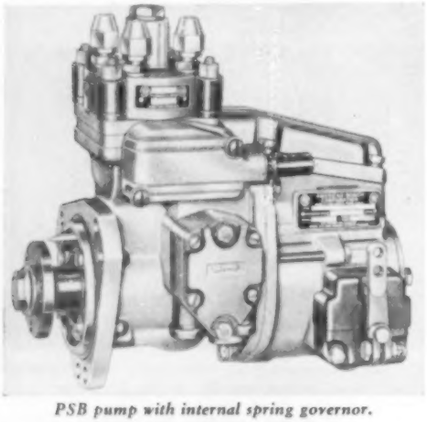


One of three 5 kw. Allen diesel generating sets, supplied for the Canadain Pacific liner EMPRESS OF BRITAIN. The diesel engines (built under licence from Harland and Wolff) are fitted with Bryce fuel injectors.

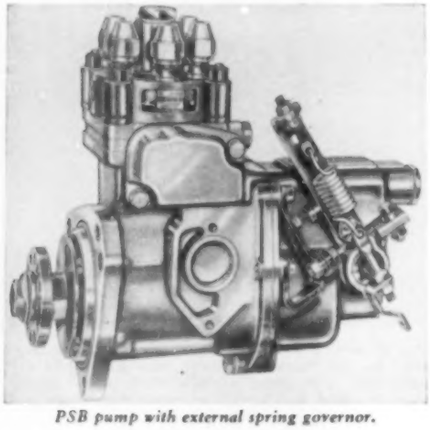
AMERICAN BOSCH

BROADER each year in its coverage of the injection requirements of the Diesel engine industry is the American Bosch line of fuel injection equipment and related accessories. Having for many years covered the engine size range with injection pumps and spray nozzles suitable for cylinders up to thirty or more inches in bore, American Bosch has concentrated in recent years on the development of especially low cost equipment for small engines, particularly those for farm tractors, and especially rugged equipment for larger engines, particularly those for locomotives and heavy trucks; also on the development of fuel filters of exceptionally high efficiency.

Despite the broad range of types and sizes it is possible to generalize on the American Bosch fuel injection line in some respects. All pumps are of the constant-stroke, cam-actuated, lapped-plunger type. All injection valves or nozzles are of the hydraulically-actuated type. The third important element of the system is the high pressure discharge tubing, except in those few cases where pump and nozzle are combined as a unit injector. These three elements form a hydraulic system in which all three must be properly correlated to each other and to the combustion chamber of the engine involved.



PSB pump with internal spring governor.



PSB pump with external spring governor.

PSB Distributor Type Pump

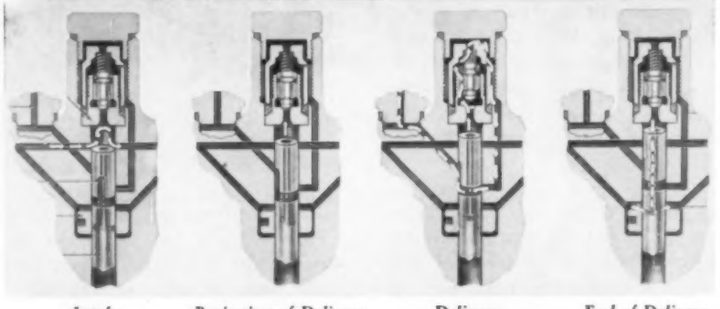
The important single-plunger multi-cylinder American Bosch injection pump known as the PSB is in wide use on many thousands of small diesel engines in the industrial, marine and transportation fields and especially in the farm tractor field. The PSB is a pump of the cam-actuated constant-stroke type of simple construction and designed for flexibility of application and economy of service. The hydraulic head assembly contains only a single plunger and single delivery valve to serve all engine cylinders. The plunger, in addition to being reciprocated by a multi-lobe cam profile through a tappet roller assembly, is also rotated at one-half engine speed by a quill shaft gear train to serve as its own distributor. Quantity of fuel delivered per stroke is governed by the axial positioning on the plunger of a closely fitted free-sliding sleeve which is limited to motion imparted through an eccentric pin-lever arrangement by the governor.

The hydraulic head is a complete assembly, fastened to the housing by four studs. The assembly consists of the head block, the lapped plunger, the control sleeve, the plunger drive-gear, the delivery valve assembly and the plunger return springs held in place with spring seats and retainer. The hydraulic head assembly requires no calibration. The single unit assures uniformity of discharge at all outlets and requires only total flow setting. It can easily be removed in the field for service or replacement.

Pressure lubricated by engine lube oil, the PSB pump is flange mounted and operates at engine speed on 4-, 6-, and 8-cylinder four-stroke-cycle engines. The fuel transfer pump is of the positive displacement gear type driven by the PSB's camshaft. Pressure regulation may be obtained if required from a valve incorporated in the transfer pump cover.

The PSB pump is adapted to the use of a governor controlling not only the engine speed, but also the maximum quantity of fuel deliverable at var-

PUMPING PRINCIPLE OF PSB PUMP



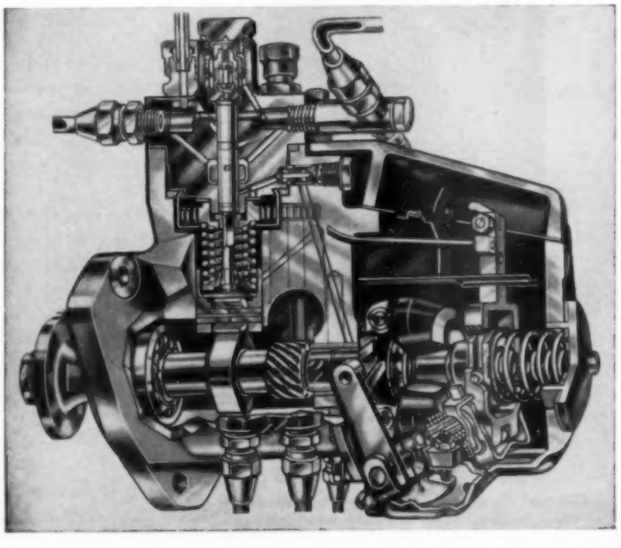
Intake *(Ports open Delivery valve closed)*

Beginning of Delivery *(Ports closed Delivery valve opening)*

Delivery *(Ports closed Delivery valve opened)*

End of Delivery *(Spill annulus opened)*

Sectional view of PSB pump with governor.



ious speeds, hence is appropriate for service in which accurate torque control for greater "lugging" power is desirable. The standard PSB pump employs the well known internal spring governor which renders it suitable for any predetermined condition of full or part-load regulation with its fine adjustment features and inherent mechanical control of the torque curve. A special "Y" execution employs a simple type governor with external extension spring for control of engine speed and regulation, relying on a modified delivery valve for control of the fuel delivery characteristic or torque curve.

The PSB-EH execution is a heavy duty pump developed for the more rugged high speed automotive applications and incorporates certain added features for protection against elements of wear and fatigue which can be promoted by destructive torsional vibrations in such applications.

APE Type Pumps

One of the older basic types of American Bosch fuel injection pumps is the APE, which is essentially a multi-cylinder multi-plunger helix-metering type with self-contained drive. This design, built in three different sizes and for numbers of cylinders from one to eight inclusive has been generally used on high speed engines for automotive, industrial and marine service. It consists in the main of an aluminum or iron alloy housing with camshaft compartment in the lower section and with as many pump elements in the middle and upper sections as there are cylinders in the engine.

The lower compartment houses the camshaft and is a reservoir for the lubricating oil. The camshaft is supported at each end by a ball bearing. The camshaft in a pump having more than six plungers is additionally supported by a bronze center bearing. A plate at each end of the camshaft compartment contains the camshaft ball bearings and oil seals. The tapered and threaded ends of the camshaft, with woodruff keyways, extend through the end plates for attachment of drive coupling, timing device, and/or mechanical governor. Camshafts are available with the cams positioned for all conventional engine firing orders. The base closing plugs contain oil-saturated felt pads which the cam lobes contact to insure adequate lubrication. Some types of APE pumps are pressure lubricated by the engine lube oil.

The plunger and spring compartment is separated from the camshaft compartment by a heavy bridge containing the bores for the tappet and roller assemblies. The adjustable tappet screws directly contact the lower end of the plungers. The plunger and barrel assemblies extend into this compartment and each plunger element has its individual control sleeve and cadmium-plated return spring. The slots on the lower end of the control sleeve are engaged by a cross-head on the plunger of the APE-A and B pumps, and by a tongued ferrule secured to the lower end of the plunger on the APE-Z pump. The adjustable gear segment on the control sleeve engages the teeth of the control rack.

The large opening on the plunger and spring compartment provides ready access for calibration and timing adjustments.

The header section contains the fuel sump and is tapped for the delivery valve holders. The barrel shoulder rests on a seat just below the sump cavity. The barrel head, having the inlet and by-pass ports, projects into the fuel sump and is located angularly by a locating screw. The lapped surfaces of the barrel head and the delivery valve assembly are held together and, as a unit, are sealed against leakage by a soft copper-asbestos gasket or solid copper gasket which the delivery valve holder tightly presses into position on the top side of the valve body flange. The fuel outlet end of the delivery valve holder, which houses the delivery valve spring, has a union nut connection for the injection tubing.

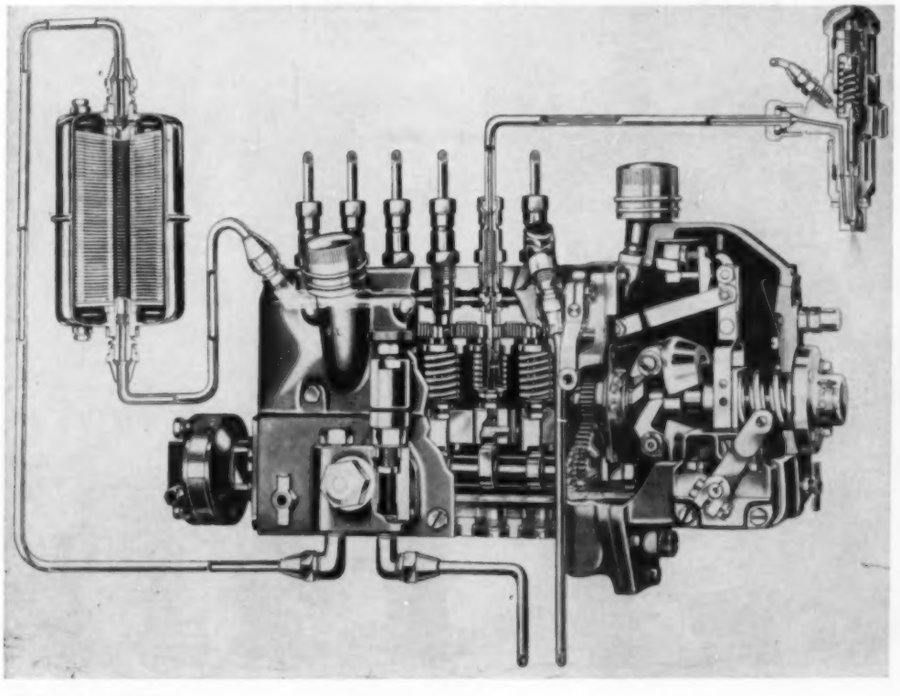
The type APE pumps with self-contained drive are either base-mounted on a bracket attached to the crankcase of the engine, in which case they are coupling-driven, or are flange-mounted to the timing gear case, in which instance drive is usually by gear or chain. In either case the pumps are ordinarily fitted with both fuel supply pump and governor. These pumps having one plunger for each engine cylinder are driven at one-half engine speed on four-stroke-cycle engines and at engine speed on two-stroke-cycle engines.

APF Type Pumps

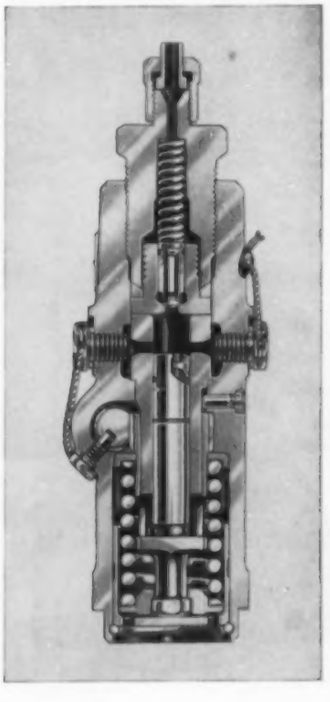
Another of the older basic types of American Bosch fuel injection pumps is the APF, which is essentially a single-cylinder helix-metering type very similar to the APE except for the absence of a drive. These pumps are intended primarily for mounting one-per-cylinder on engines of medium and large size, hence have alloy iron housings and considerably greater pressure capacity.

They are designed to be flange-mounted directly over the camshaft and tappet mechanisms provided by the engine manufacturer and to be actuated by the tappet in contact with the center of the plunger guide cup. Operation of the APE and APF types is identical hydraulically. The APF is manufactured in ten different sizes, the largest being adequate for the very largest engines.

Sectional view of typical American Bosch APE pump fuel injection system.



Sectional view of type APF pump.



APF Dual Plunger Pumps

These pumps developed initially for dual-fuel engines differ from the conventional APF pumps in that for injecting small ignition-fuel quantities they incorporate a smaller diameter plunger above, and actuated by, the larger diameter main plunger. The metering land of the small plunger is usually fixed to give an ignition-fuel charge of 4 to 7 per cent of the full load quantity, while the main plunger has a helix for variable fuel control on full diesel operation. The small plunger may be positioned to close its inlet port ahead or after the main plunger to effect an advance or retard of the ignition injection. Two delivery valves are provided, one for each plunger, with a common discharge outlet so that both plungers inject through the same nozzle.

Another arrangement provides for telescopically related main and pilot plungers permitting a more compact pump design. Pilot plungers can be arranged to give constant delivery with constant timing, constant delivery with variable timing or variable delivery with constant timing.

Other American Bosch pumps for dual-fuel engines are available which are identical with the standard APF pump except that the plungers incorporate special helix arrangements to make them more suitable for dual fuel operation.

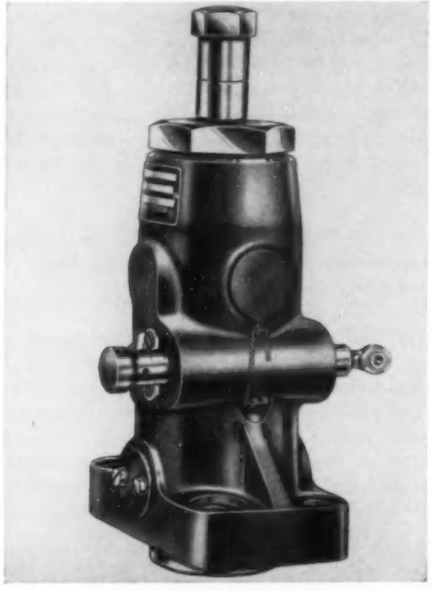
PUB and PLB Type Pumps

The American Bosch type PUB pumping unit is intended for submerged mounting within the structure of the engine, the supporting flange being near the upper end instead of at the bottom as in the case of APF pumps. Otherwise the construction of the two types is similar and their operation is identical.

The American Bosch type PLB injection pump is also intended for submerged mounting, with supporting flange nearer the upper than the lower end. The PLB is also identical with the PUB and the APF in hydraulic operation. Instead of having a control rod, however, whose linear motion is translated into control sleeve rotation for varying the fuel quantity delivered, the PLB pump has a rockshaft lever at the front end which serves the same function. On some engines this provides a more convenient connection to the governor.

The PUB and PLB pumps without self-contained drive are built in only one size and in only one-cylinder execution, but they are well adapted to use in multiples on multi-cylinder engines.

APF dual plunger pump for dual fuel engines.



Exceptionally ruggedly constructed APF . . . CQ pump for larger engines.

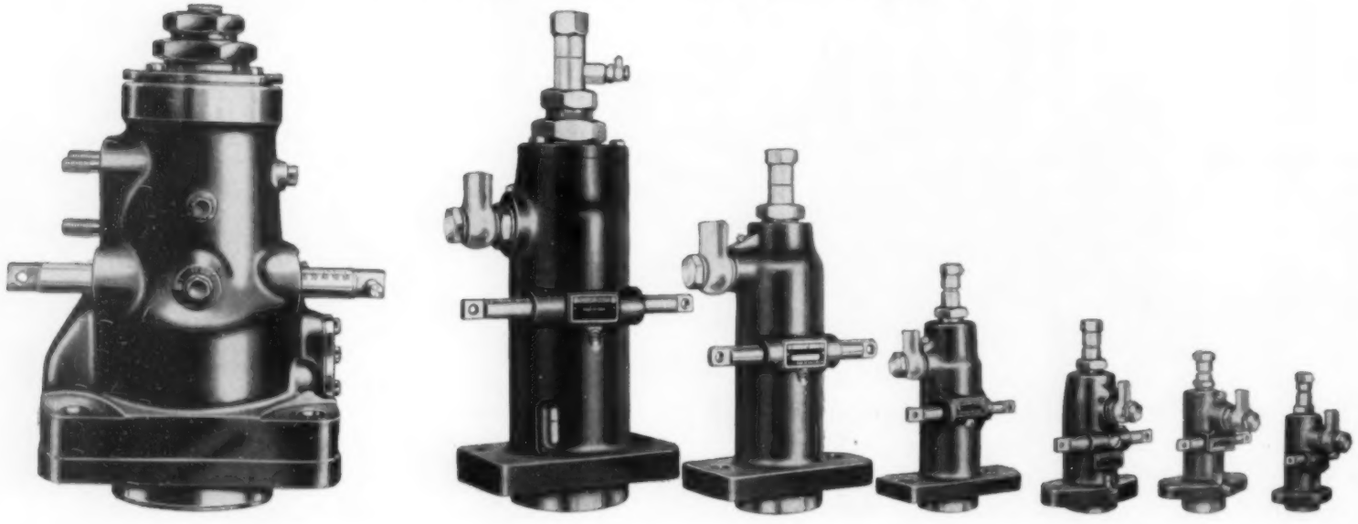
Governors

American Bosch manufactures several forms of governors, exclusively for application to the types APE and PSB injection pumps. Most of these are of the centrifugal mechanical type but one is of the pneumatic type, actuated by the pressure differential of the engine intake manifold. All are directly connected to the injection pump metering control without external linkages and form a compact pump-and-governor unit.

The purpose of these governors is primarily control of engine speed under all conditions, including idling. The mechanical governors usually incorporate in addition, however a torque control feature which has important advantages for engine service in which load is not proportional to speed.

This torque control regulates the maximum delivery of the injection pump in accordance with the ability of the engine to burn fuel over the speed range as established by the manufacturer.

Portion of the American Bosch line of APF pumps showing wide range of sizes.



Spray Nozzles

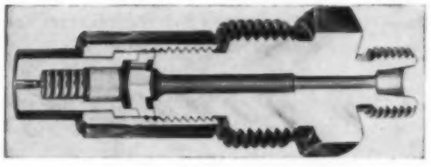
American Bosch produces a wide variety of spray nozzles, in six different sizes, to meet the requirements of the many combustion systems and engine sizes; but essentially there are two basic groups, namely, pintle nozzles and hole nozzles. Both are of the hydraulically-actuated differential-needle type whose valve opening pressure is substantially greater than its closing pressure, thereby promoting sharp cut-off.

In the case of the pintle group, the nozzle valve carries an extension at its lower end in the form of a pin which protrudes through the orifice in the nozzle bottom. This requires the injected fuel to pass through an annular orifice, thus producing a finely atomized cone-shaped spray the included angle of which can be small or large depending upon the form of pintle selected. The projection of the pintle through the nozzle orifice provides a self-cleaning effect which is important. Pintle-type nozzles are generally used in engines having pre-combustion chambers, divided chambers, and air or energy cells. American Bosch throttling nozzles of the pintle type are extensively used in small-bore high-speed engines; these are similar but have greater valve movement and greater initial restriction to fuel flow.

The hole-type nozzles have no pintle on the valve end. They have one or more spray orifices which are precision-drilled round holes through the tip of the nozzle body beneath the valve seat. The general spray pattern is determined by the number and arrangement of the holes; there are sometimes a dozen or more, and they are sometimes as small at 0.006 in. in diameter. Hole-type nozzles are usually associated with open-chamber direct-injection combustion systems.

American Bosch manufactures a wide variety of nozzle holders to position the nozzles correctly in the engines and to provide a means for conducting fuel to them. The nozzle holder also contains the nozzle valve spring and the necessary provision for adjustment of its tension. A comparatively recent development is the type AKK spindleless nozzle holder, devised primarily for use in high-speed high-output engines. Here the spring is down close to the nozzle instead of in the upper portion of the holder body.

Another recent development, which is expected to contribute to the reduction in cost of fuel injection equipment, is the type AKS screw-in holder which makes use of an outwardly opening poppet nozzle requiring no leak-off.

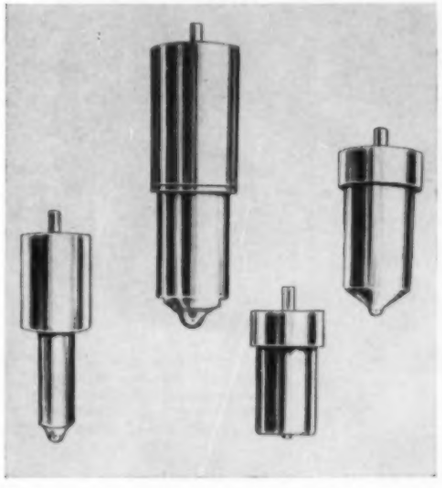


Above: Sectional view of simplified AKS type nozzle holder with ADE nozzle.

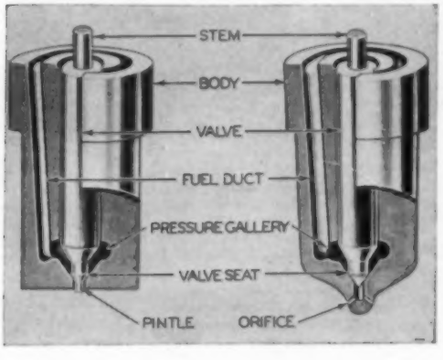
Left: Sectional view of AKK nozzle holder with nozzle.

Below: Sectional view of AKF type nozzle holder with nozzle.

Below: Various types of American Bosch nozzles: ADB hole type extra long, ADA hole type integrally cooled, ADN pintle type, ADL hole type.



Below: Cross-sections of typical pintle (left) and hole (right) nozzle.

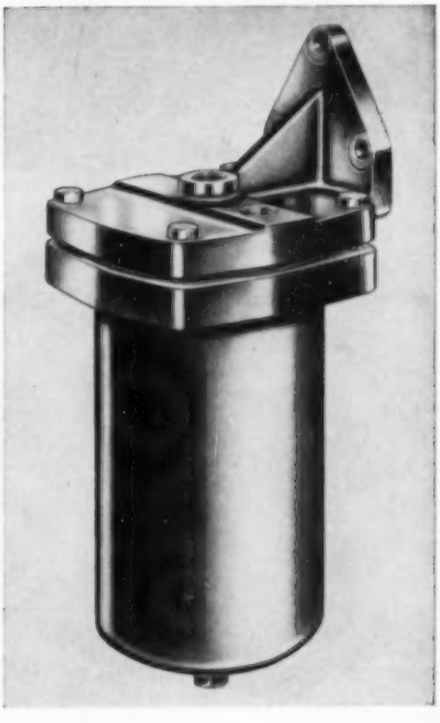


Filters

Intensive development work on fuel filters during the past few years has produced for American Bosch the two new types FSA and FRB, the former a sealed final-stage unit for tractor and truck engines, the latter a replaceable-cartridge final-stage unit of considerable size for larger engines (locomotive, marine, stationary). Both of these filters combine high efficiency with high flow capacity and provide effective protection against dirt particles all the way down to one or two microns in size, even in the presence of water.

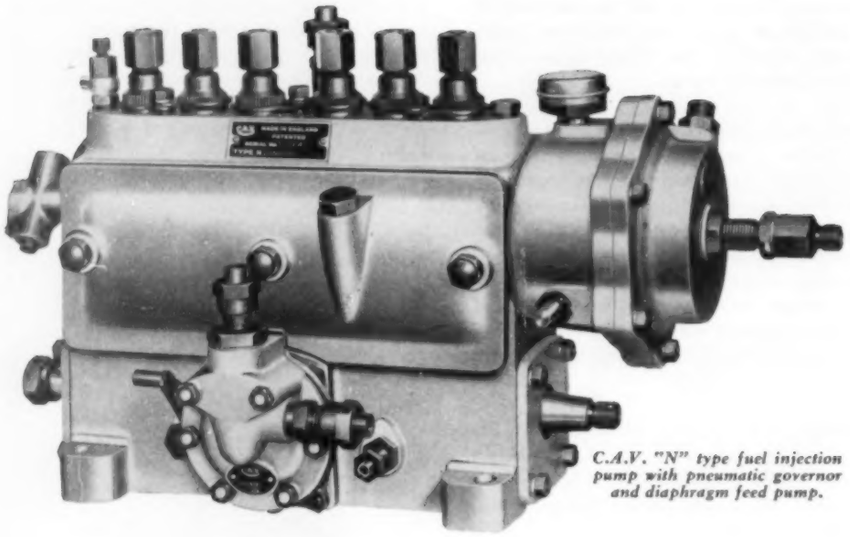
Type FSA sealed final-stage fuel filter.

Type FRB replaceable element final-stage filter for larger engines.

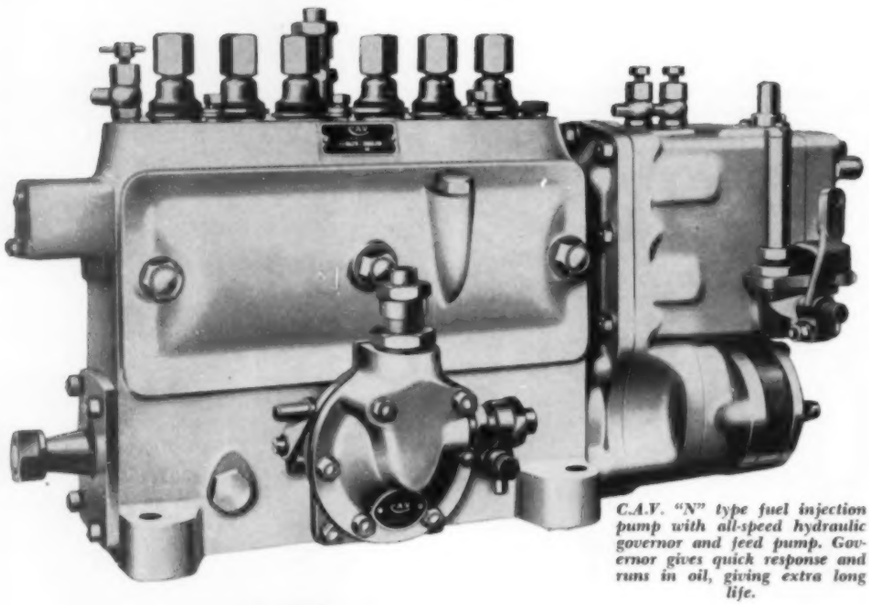


C. A. V.

FUEL INJECTION EQUIPMENT



C.A.V. "N" type fuel injection pump with pneumatic governor and diaphragm feed pump.

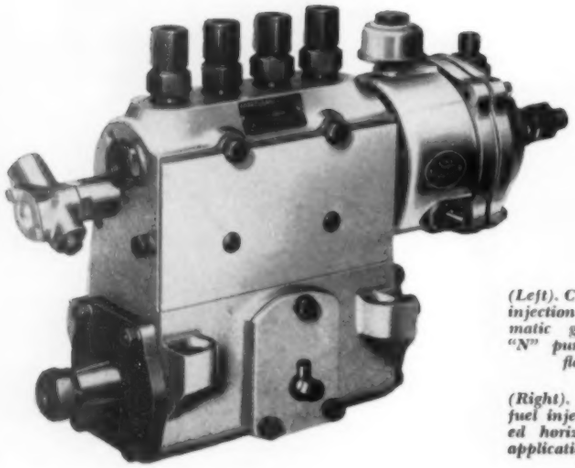


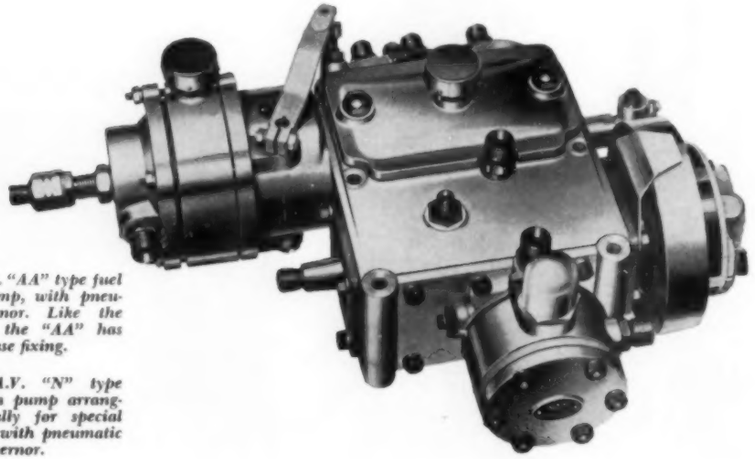
C.A.V. "N" type fuel injection pump with all-speed hydraulic governor and feed pump. Governor gives quick response and runs in oil, giving extra long life.

C. A. V. fuel injection equipment covers the requirements of the widest range of Diesel engines of all powers up to 600 bhp. per cylinder, including high speed engines for transport vehicles, marine engines, agricultural and other types of tractor and portable and stationary power plants. It comprises an extensive range of fuel injection pumps, pump governors, injectors and spray nozzles, fuel oil filters, feed or transfer pumps, etc., and is backed by one of the largest manufacturing and research organizations in the world, ensuring the highest standards of design and production so necessary for successful Diesel operation. C. A. V. equipment has been developed to satisfy the exacting requirements of high speed direct injection engines with their more onerous problems than those of air-cell type. Recent developments include equipment for high speed 2-stroke engines and for diesels specially suitable for light vehicles.

Fuel Injection Pumps—Two main types of C. A. V. injection pumps are built, the self-contained camshaft type with camshaft and tappet mechanism enclosed in a monobloc pump housing, and the flange mounted type, in which the camshaft and tappet gear form part of the engine proper.

All C. A. V. injection pumps are of the jerk type, with constant stroke, cam operated, lapped plungers, provided with control helices; rotation of the plungers by means of the control rod provides for metering of the fuel. The delivery valves are of special design, with lapped cylindrical pressure unloading pistons; this feature eliminates "dribble" at the nozzle, ensuring good combustion and freedom from carbonization. Provision is made for dust-proofing all pumps. Pumps for marine duty are supplied in special protective finish to withstand corrosion of fresh and salt water. "BPE-A, -B," "AA" and "N" type pumps may be fitted with pneumatic or mechanical governors, the latter including maximum and minimum speed (idling) control, and all-speed control types. Plunger or diaphragm type feed pumps may be fitted.





(Left). C.A.V. "AA" type fuel injection pump, with pneumatic governor. Like the "N" pump, the "AA" has flat base fixing.

(Right). C.A.V. "N" type fuel injection pump arranged horizontally for special applications, with pneumatic governor.

Typical C.A.V. fuel injection nozzle holders and pintle type nozzles.

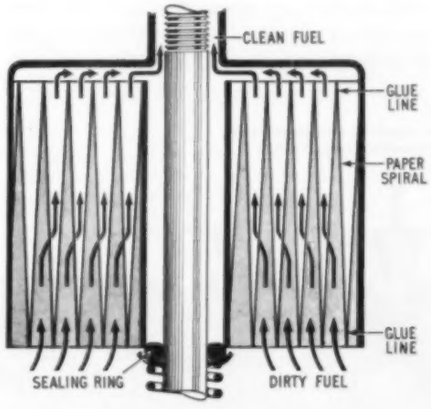
"N" Type Injection Pump—Main features of this type include: built-in final filter, providing full and permanent protection to pump from dirt which may have passed the main filters when latter are being serviced; flat-base pump fixing; stiffer camshaft, larger bearing areas; positive phasing adjustment. This pump may also be fitted with hydraulic governor.

Pneumatic Governor—Specially suitable for vehicle and tractor use, the C. A. V. pneumatic governor as fitted to "BPE," "AA" and "N" pumps is growing in popularity; it comprises venturi control unit fitted in induction manifold; diaphragm unit fitted to injection pump, and connecting pipe. Movement of the accelerator pedal operates butterfly valve in air inlet, and the change in pressure in induction pipe is communicated by the connecting pipe to the diaphragm chamber, which in turn operates the control rod.

Spray Nozzles—A wide variety of nozzles is available, to suit all types of engine and combustion chamber. Basic types include: single hole, multi-hole, long-stem, pintle and delay pintle types. The long-stem type is employed in large numbers, the design enabling the closely fitting portion of valve and body to be removed from the point of greatest heat. Poppet nozzles can also be supplied.

"Pintaux" Nozzle—A special type of nozzle designed for use with engines using "Ricardo" type combustion chambers, and to give greatly improved starting characteristics, is the C.A.V.-Ricardo "Pintaux." This consists essentially of a nozzle basically of the pintle type, but with the addition of an auxiliary spray hole so located in relation to the needle valve seat that on the needle lifting, the auxiliary spray comes first into action, followed by the main jet only after the pintle has lifted sufficiently to open the main orifice. With a normal nozzle, the jet is directed along the path of swirl in the combustion chamber, but while this gives good results when running it is not the best condition for easy starting from cold. With the "Pintaux" nozzle, in the starting position the pintle is partly lifted, and the bulk of the fuel is sprayed from the auxiliary jet into the central part of the chamber where the heat is greatest. At this point the main jet is just commencing. As the engine gains speed, the pintle lifts further, and the main jet is then directed along the normal path, the auxiliary side jet being greatly reduced.

Fuel Filters—The new type "F" paper element fuel oil filter is a great advance on previous designs, and offers greatly increased fuel injection equipment life. The container is smaller than in earlier types, yet the element contains 560 sq. in. of filtering surface. Paper is formed in spiral vees, and is specially impregnated to give extra strength. Removes finest dust and will filter large volumes of dirty fuel without choking. Supplied in a metal container, the new element is simple to handle and easily replaced in a few moments when choked. Exhaustive field tests under arduous conditions have shown it possible to obtain up to six times the former injection equipment life. Initially low priced and cheap to maintain, the new filter will greatly reduce equipment overhaul costs and help to keep engines in service.



FLOW THROUGH FILTER ELEMENT

Diagram showing flow of fuel through C.A.V. paper element filter.

Conversion kits are available enabling many earlier types of felt or cloth element C.A.V. filters to be converted to take paper elements; the benefits of improved filtration, greatly reduced maintenance costs, etc., can thus be obtained at minimum cost.

Twin and triple bowl filters are also available to suit special conditions. These are supplied with a common cover for operation in parallel.

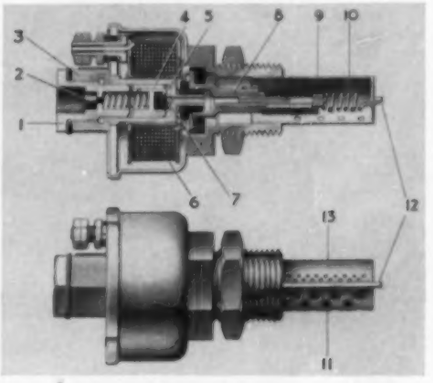
"Thermostart" Starting Aid for diesels.—Employs same fuel as the engine, thus avoiding difficulties of

C.A.V. "F" type paper element fuel oil filter, cut-away, showing oil flow and coiled vee paper element inside container.

supply arising from use of a special fuel. Suitable for temperatures down to 10° F (-12° C). Electrically operated from operator's control position. Starting is effected in a few seconds, saving in time and battery drainage.

The "Thermostart" is located in induction manifold. When switch is operated, a solenoid (6 in figure) lifts a valve (4) with soft insert (5) from its seat (7). Fuel from a small tank enters at (1) and flows at controlled rate over electric heater coils (9, 10) situated in perforated shield (13). Fuel is vaporised, and ignited when engine is cranked and air is drawn into manifold. Mixture burns from holes (11) in shield, heating induction air as it enters cylinder.

At starting, "Thermostart" is switched on for 10-15 seconds, then electric starter is engaged. Overall length of device 3⅞ in. Installation is governed by position of main fuel tank, space available, etc., but a gravity head of a few inches is all that is required.



C.A.V. "Thermostart" Starting Aid for diesel engines.

DEMCO
MICRO PRECISION DIVISION OF MICROMATIC HONE CORPORATION

FUEL INJECTION EQUIPMENT

THE Demco Fuel Injection Equipment is produced by an organization, which for the past twenty-four years has been solely engaged in precision manufacture.

Micro Precision, Inc. manufactures a complete line of fuel injection equipment including the Type "PB" Fuel Injection Pumps with self-contained drive; Type "PF" for individual drive and flange mounting; Type "IPFNB" for small Diesels; Nozzles of the multi-hole and pintle types in various sizes; Nozzle Holders to fit every size of nozzle and in any desired length; and Fuel Supply Pumps and Flexible Drive Couplings.

Most DEMCO Fuel Injection Pumps are of the port controlled type—the quantity of fuel injected per stroke being controlled by a metering helix on the plunger. Rotation of the plunger in the barrel varies the relative position of helix and spill port and thereby changes pump delivery. Plunger is rotated by rack and pinion movement.

"Demco" PB Fuel Injection Pump

DEMCO Type "PB" Multiple-Unit In-Line Fuel Injection Pumps are constant stroke, cam operated with self-contained drive. They are built in sizes from three to eight pump units. The six-unit pump is illustrated below.

The Type "PB" Fuel Injection Pump is contained in a rugged cast aluminum housing. The camshaft compartment is located in the lower section of the housing and the middle and upper sections contain as many plungers and barrels, or pumping unit assemblies, as there are cylinders in the engine. Absence of large openings in the housing insures against contamination of working parts and provides extremely stiff pump housing.

The Camshaft rides on two heavy duty ball bearings, and in the six and eight-unit pumps an intermediate plain bearing is employed in addition to the two ball bearings.

Individual cams operate the pumping units by means of roller tappets.

Several standard cam contours are available to accommodate specific engine requirements. Tappets are equipped with needle bearings and do not require adjustment for timing.

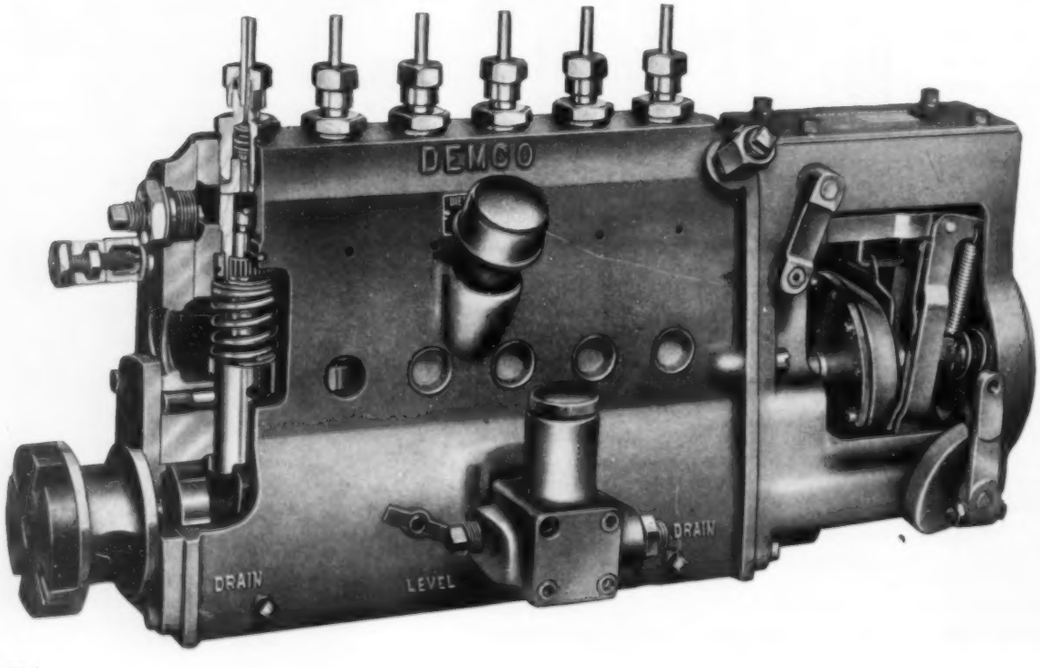
An outstanding feature of the DEMCO Type "PB" Pumps is the removable plunger and barrel assembly. The plunger and barrel assembly may be removed from the pump housing upwards without the necessity of removing the camshaft and tappets. A new plunger and barrel assembly (pumping unit) can be installed in the housing without requiring recalibration. This feature greatly simplifies the servicing of DEMCO injection equipment in the field and enables the operator to keep his equipment performing at maximum efficiency with minimum cost and shut-down time.

Metering of each pumping unit is adjusted and sealed at the factory and the plungers and barrels, or pumping units, are manufactured to such close tolerances that uniform calibration will be maintained between the units when new units are installed. Plungers and barrels are made of special steel of recent development, assuring not only high hardness but excellent surface finish and wearing qualities.

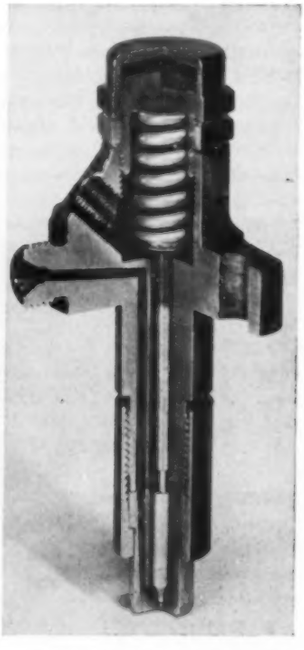
All external or installation dimensions such as base, camshaft height, control rack location and movement, pipe connections, etc., conform to SAE standards.

DEMCO Type "PB" Fuel Injection Pumps may be furnished with such auxiliary equipment as fuel supply pump, adjustable drive coupling and full range speed governor.

View of DEMCO six cylinder fuel injection pumps partially cut away to show pump and governor construction.



Typical section of nozzle holder and pintle nozzle.



The DEMCO supply pump is an independent assembly and is attached to the injection pump housing by four screws. It is of the single acting piston type with variable stroke. Stroke is automatically controlled by the quantity discharged by the injection pump. This supply pump will maintain a constant supply pressure. A hand operated priming pump is an integral part of the pump.

A DEMCO designed governor of the variable speed type is available for the type "PB" pumps. It is a self-contained assembly, flange mounting on the pump.

Nozzles and Nozzle Holders

DEMCO Nozzles are of hydraulically operated, differential, closed type. They are operated by the fuel pressure acting against the spring loaded differential area type fuel needle.

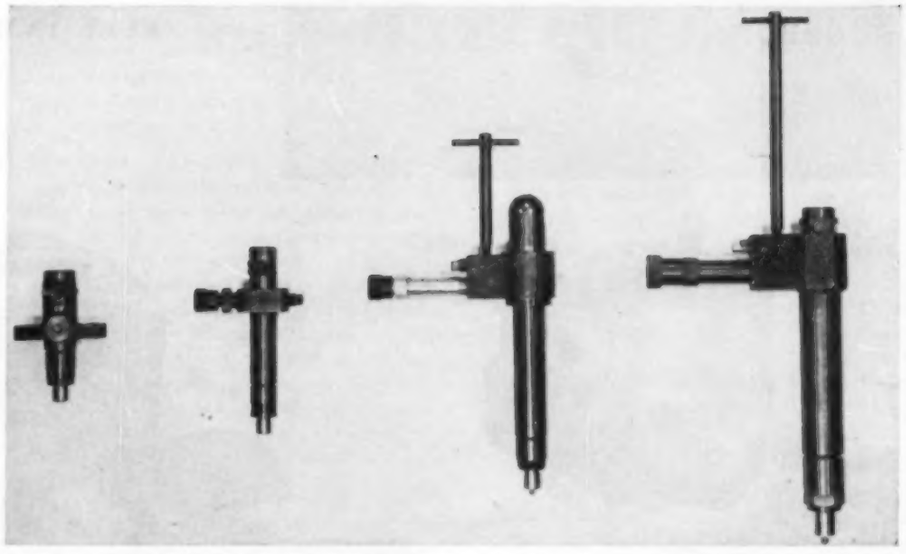
DEMCO manufactures a full line of multi-hole nozzles applicable to all sizes of Diesel engines. These nozzles are made in three sizes with shank diameters of .547", .700" and .979" respectively. They are made of either standard or special corrosion resisting material, depending on the individual requirements. Nozzles are interchangeable with other makes of similar design.

DEMCO also manufactures a line of Pintle Nozzles for Diesel engines of the divided combustion chamber type, such as the pre-combustion chamber or energy cell types.

"Demco" 1PFNB Fuel Injection Pump

The Demco IPFNB Pump was primarily designed for small Diesel engines. For this particular application the following important requirements were kept foremost in mind:

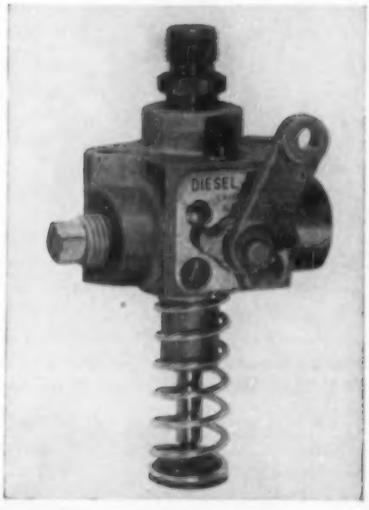
1. Simplest possible design and construction.
2. Maximum reliability in service.
3. Ease of servicing.
4. Ease of installation on engine without any adjustment of timing.
5. Replacement of a pump without disturbing the fuel quantity control.
6. Use of flat tappet follower.
7. Minimum governor force requirement.
8. PFNB Pumps are furnished with SAE submerged Pump Mounting No. 1.
9. Last but not least, low cost.



Typical group of nozzle holders with nozzles.

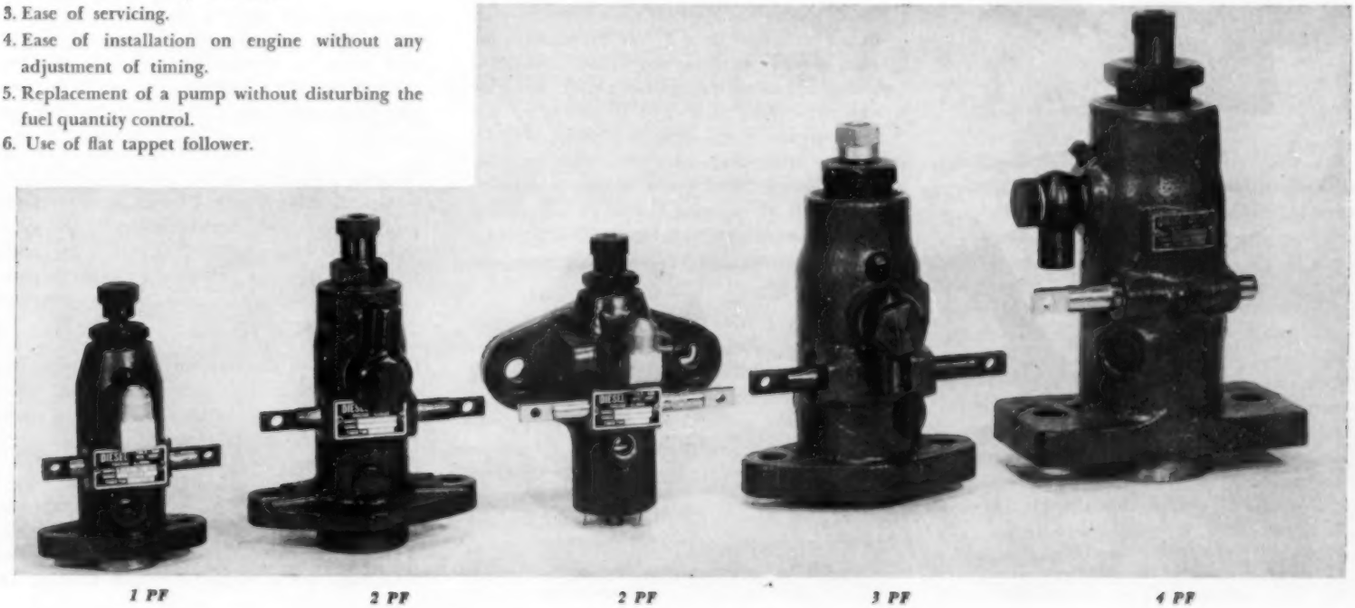
"Demco" PF Fuel Injection Pumps

DEMCO type PF pumps are of the flange mounted type and are available with plunger diameters from 5 mm to 22 mm and strokes from 7 mm to 18 mm. They are furnished with mountings corresponding to SAE unit mounting No. 1, 2 and 3 and special configurations. Heavy duty pumps of PE type can be furnished for peak injection pressure of up to 25,000 PSI and pump speeds of up to 3,000 RPM.



Low cost single unit fuel injection pump Type 1PFNB.

Single unit flange mounted pumps.



1 PF *2 PF* *2 PF* *3 PF* *4 PF*

ROOSA MASTER

FUEL INJECTION EQUIPMENT

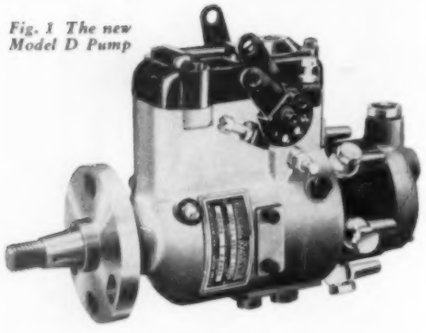


Fig. 1 The new Model D Pump

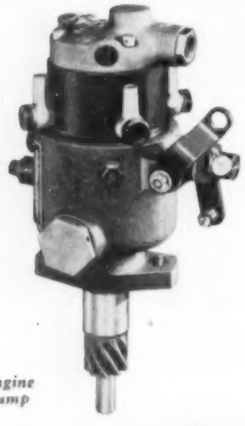


Fig. 2 Engine governed pump

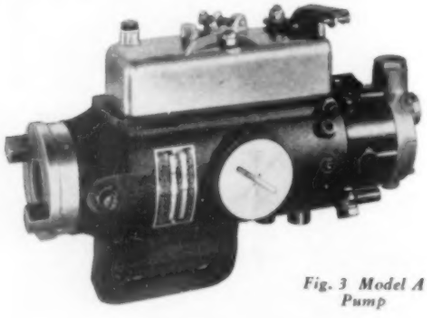


Fig. 3 Model A Pump

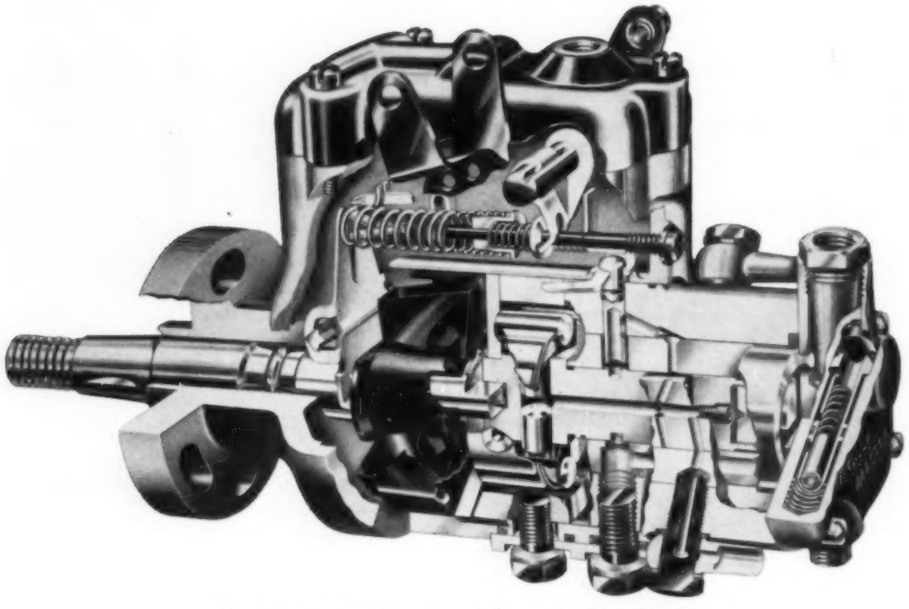


Fig. 4 Sectional cutaway view of the new Model D Pump

AS ANOTHER major step toward simplifying Diesel fuel injection, the Hartford Machine Screw Company, Division of Standard Screw Company, has added the new Model D to their Roosa Master family of fuel injection pumps. The product of more than 15 years of continuous development, the Model D (Fig. 1) is of the same single cylinder, opposed plunger, inlet metering, distributor type as other Roosa Master pumps such as the Model A (Fig. 3). Extremely compact, measuring only 8" in overall length, the Model D pump is built to operate two and four cycle engines of 2, 3, 4 and 6 cylinders and four cycle, 8 cylinder engines successfully with a recommended fuel output of up to approximately 125 cubic millimeters per stroke. However, operation has been satisfactory with engines requiring considerably greater fuel delivery.

THE ROOSA MASTER MODEL D is designed to operate in any position and is completely self contained in its housing, including its own mechanical flyweight governor and built-in positive displacement, vane type, fuel transfer pump. Its simplicity of design, with about 70 different parts in the basic model, makes possible easier manufacturing, lower service costs, greater dependability and operating speeds. Regardless of the number of engine cylinders served, the number of parts in the Roosa Master remains the same.

MOUNTING—The Model D has a single universal housing permitting 2 or 3 hole flange mounting in any position, including the vertical. This allows the engine manufacturer to use a single block for either heavy duty gasoline or Diesel engines. An engine governed version of this pump (Fig. 2), currently being produced and utilizing the existing engine governor, has a shorter housing, is usually vertically mounted and has an independent shut-off lever. Other than having no governor parts, this version is the same in design and operation as the basic Model D pump.

CONSTRUCTION—There are no spring loaded, lapped surfaces, poppet valves, ball bearings, gears or highly stressed springs and the same housing mounts all Roosa Master accessories, most of which are built in. The Model D is completely self-lubricated by the filtered fuel it pumps. Its housing (Fig. 4) forms an oil tight compartment in which pressure is maintained, thus preventing the entrance of dust, water or any foreign material during operation.

CALIBRATION, or balancing outputs of the different pumping elements, is not necessary in the Roosa Master pump. Timing between engine cylinders and pump sequences, inherent in the pump design, is determined by accurate manufacture and cannot be altered during assembly of the pump or by any other means.

OF THE EIGHT MAIN COMPONENTS (Fig. 4) only three are rotating. The drive shaft engages the distributor rotor by a tang-in-slot arrangement and causes it to revolve in the hydraulic head. The drive end of the rotor houses the diametrically opposed plungers in the pumping cylinder. The plungers are actuated toward each other by a stationary internal cam ring through two rollers and shoes. Normally the cam ring has as many lobes as there are cylinders to be served.

An axial bore connects the pumping cylinder to a single discharge port and the charging ports (as many as there are cylinders served) in the rotor shank. The hydraulic head, in which the rotor turns, contains the metering valve and outlet ports to the injection line connectors leading to the engine cylinders.

On the end of the rotor opposite the pumping cylinder is the positive displacement, vane type, transfer pump. The end plate, covering the transfer pump, houses the fuel inlet and outlet passages, the inlet strainer and pressure regulating valve.

Mounted to the drive end of the rotor are the governor weight retainer and governor weights. This type of governor derives its energy from the centrifugal action of the flyweights pivoting on

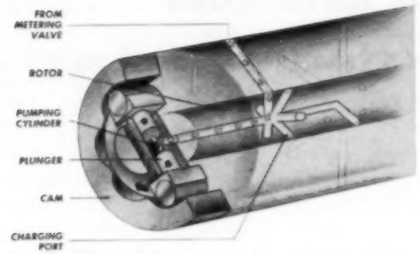


Fig. 5 Sectional diagram of the Model D rotor in charging position in the hydraulic head.

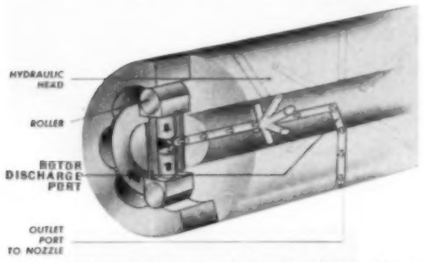


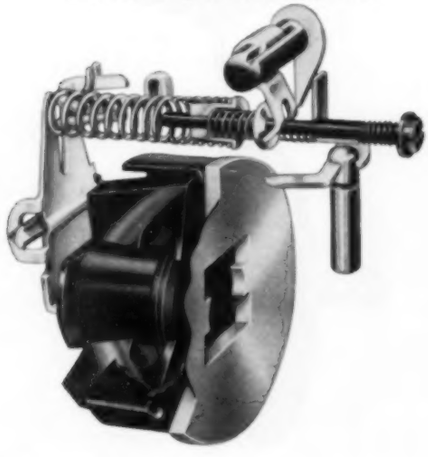
Fig. 6 Sectional diagram of the Model D rotor in discharging position in the hydraulic head.

their outer edges in the retainer. Centrifugal force tips them outward, moving the governor thrust sleeve against the governor arm. Pivoting on the knife edge of the pivot shaft, the governor arm is connected through a positive linkage to the metering valve. This simple governor linkage, with no complicated toggles and operating in the oil filled pump housing, is extremely sensitive and damped to prevent rapid and wide fluctuation. Using a compression type spring, this governor is capable of extremely close regulation over a wide speed range.

A SIMPLE, BUILT-IN, ADJUSTABLE TORQUE CONTROL is available on the Model D pump as standard equipment. An external screw in the side of the housing contacts the metering valve arm and renders the governor inactive at a predetermined point as the engine slows under increased load. This device permits the setting of a point of maximum torque for various requirements over a broad range of speeds.

OPERATION—Fuel is drawn through the inlet strainer in the end plate by the transfer pump.

Fig. 7 Cutaway view of Model D flyweight type governor and linkage to the metering valve.



Since transfer pump displacement greatly exceeds injection requirements, a large percentage of fuel is by-passed back to the inlet side through the pressure regulating valve which causes both the amount of fuel by-passed and transfer pump pressure to increase with speed.

Fuel is then forced through the hydraulic head, around an annular groove in the rotor shank and through the metering valve, regulated by the engine demand. When one of the charging ports in the rotor (Fig. 5) comes into register, fuel passes from the metering valve passage into the axial rotor bore and then into the pumping cylinder. The metered fuel forces the plungers outward in proportion to the fuel to be injected. The maximum outward plunger stroke, and therefore the maximum amount of fuel which may be injected is determined by the travel limit of the cam roller shoes. This limit is set by a simple adjustable spring pack.

The rotor charging port then passes out of registry and, as the discharge port comes into registry with one of the outlet ports in the hydraulic head (Fig. 6), the rollers simultaneously contact opposite lobes on the internal cam ring, forcing the plungers toward each other. This forces an amount of fuel proportionate to that trapped between plungers back through the axial bore, through the outlet port and into the injection line to the proper engine cylinder.

LUBRICATION

LUBRICATION of the pump is provided for by a bleeder slot from the annular groove on the rotor shank. As fuel is forced around the groove, a portion bleeds through the slot to a reduced shank diameter and into the pump housing at decreased pressure to lubricate all moving parts. A drain connection in the housing cover returns this fuel to the supply tank, enabling it to act as a coolant and permitting any entrapped air in the fuel to be carried out.

DRIVE

THE MODEL D PUMP may be supplied with or without the drive shaft, which is a completely separate unit. This allows removal of the pump from the engine without disturbing the timing, as the drive shaft may remain directly engaged in the engine gear train (Fig. 8). Reassembly of the pump 180° out of phase is prevented by a small, off-center locating pin in the tang end of the shaft, engaging the pump rotor. The pump mounting flange is calibrated and has elongated mounting holes for less-than-tooth timing with the engine.

ACCESSORIES

A COMPLETE LINE of Roosa Master accessories is available for use with the Model D fuel injection pump, all of which mount in or on the single universal housing.

THE ROOSA MASTER AUTOMATIC ADVANCE unit is a simple hydraulic servo-mechanism powered by transfer pump pressure to advance injection timing along a pre-determined curve with increase in speed. This device may also be used to retard injection as an aid to cold starting, and is mounted on the bottom of the D pump housing.

AN ELECTRICAL SOLENOID SHUT-OFF is available for either "energized to run" or "energized to shut-off" operation and is housed completely within the pump itself, causing no change in external dimensions. Either type of shut-off is usually supplied for a 24 volt system.

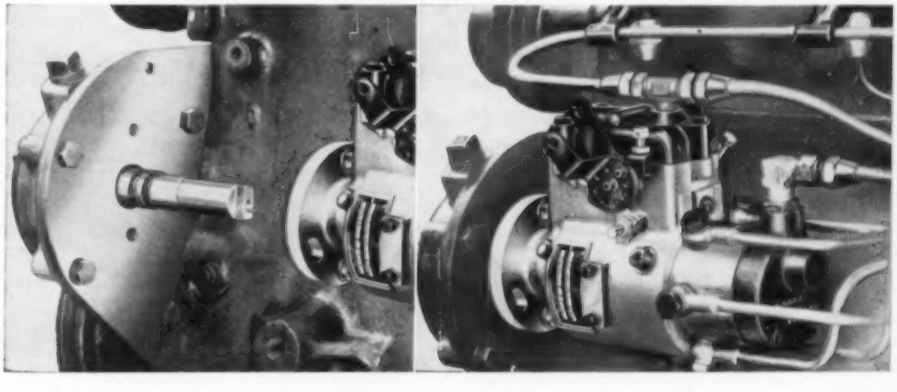
THE ROOSA MASTER STARTING AND OVERSPEED GOVERNOR mounts between the pump flange and the engine and performs the dual function of preventing the energizing of the starting circuit and overspeeding during engine operation. Using the same type of mechanical flyweight governor as the pump itself, this device energizes the electrical shut-off in the pump to stop the engine when rated speed is exceeded, while its contacts in the engine starting circuit make it necessary for the engine to come to a complete stop before it may be re-started. This governor may be wired with controls to protect the engine against low lubricating oil pressure or over heating.

THE VARIABLE SPEED DROOP DEVICE controls governor regulation during operation. An external adjustment screw on the pump housing varies the effective length of the governor spring, thus regulating governor sensitivity.

THE HAND PRIMER PUMP is used primarily for initially filling the fuel supply system after it has been opened for servicing and prevents draining of the system while the engine is not operating. It is always mounted on the inlet side of the system, before the primary filter and, when operated with the inlet fitting loosened, purges the system of air.

Fig. 8 Separate drive shaft may remain in engine gear train, leaving timing undisturbed when pump is removed.

Fig. 9 Roosa Master Model D pump mounted on engine.



WESTINGHOUSE

ELECTRIC GOVERNORS FOR ENGINE-GENERATOR SETS

THE Westinghouse electric governor is based on an electrical load sensing system which anticipates prime mover speed change in order to initiate corrective action at the earliest possible instant. It is applicable to all diesel or gasoline engine driven ac generator sets. It is particularly effective in providing automatic load sharing among two or more engine generator sets and this type of governor will permit isochronous operation of generators in parallel. Ingenious use of electrical characteristics for load sensing, frequency (speed) sensing, and paralleling control make it the most accurate constant speed governor available today. Since it actually senses changing electrical load and uses this change to anticipate speed change the electric governor is capable of faster action than conventional governors which must wait for speed change of the driving diesel or gasoline engine before going into action. The electric governor provides for automatic isochronous load sharing by two or more engine generator sets to new close limits of load division. Moreover, speed regulation of paralleled units will be at the same or better accuracy as for separate, individual sets. Basically, the Westinghouse electric governor is a single model for all makes and sizes of ac engine-generator sets. Minor size and construction differences in some of the components stem from differences in throttle actuator force requirements of the different engines and the charactristic smaller size of 400-cycle parts as compared with 50/60 cycle parts. This single design feature greatly simplifies operator instruction. Maintenance and field service also are simplified and spare parts stockage is kept to a minimum.

Highly dependable, the Westinghouse electric governor needs minimum operator attention. All electrical parts are of the rugged, static type; no electronic tubes or other relatively frail electrical or mechanical parts are employed.

Automatic load sharing within 5.% of each unit's proportionate share of the total load results in 5% added power per unit paralleled. The Westinghouse electric governor is equally effective in applications to combination ac-dc engine generator sets of the Air Force, aircraft ground support portable type. It is required only to add a simple dc transductor for dc load sensing.

ELECTRIC CONTROL UNIT—Figure 1—The electric control unit measures generator frequency, generator load and engine throttle position. This component is standard for all sizes of engine generator sets in a particular frequency rating such as for example 60/50 cps. The 400 cps control unit is somewhat smaller and lighter than the 60/50 cps unit and likewise is standard for all sizes of 400 cps generator units.

AUXILIARY PANEL—Figure 2—The auxiliary panel merely standardizes the generator output current signal. It is connected to the instrument transformer secondaries and is suppiled with one ohm or five ohm resistors depending on whether the transformer secondaries are 5 ampere or one ampere. The output voltage across these resistors hence is standardized at about 5 volts at full load on the generator.

ACTUATORS—Figure 3 and Figure 4—Figure 3 shows the medium force actuator and figure 4 the high force actuator. The medium force actuator is supplemented by the hydraulic supply unit (figure 5) and tank unit (figure 6) which are described later. The high force actuator is a self contained unit comprising actuator, hydraulic supply and tank. The high force actuator is generally applied to engine generator sets of about 500 kw rating and upward. The medium force actuator is applied to sets rated under about 500 kw.

HYDRAULIC SUPPLY—Figure 5—The hydraulic supply consists essentially of a standard oil gear pump and adapter plate for connection to any convenient drive from the engine. Engine vibrations or drive roughness has no effect on governor sensitivity or stability since the only function of the gear pump is to supply nominally 300 psi pressure to the actuator component.

TANK UNIT—Figure 6—The tank is merely a reservoir of about one gallon capacity to hold and cool the governor oil. Engine oil could be utilized thus eliminating this tank where the oil being circulated

Figure 1

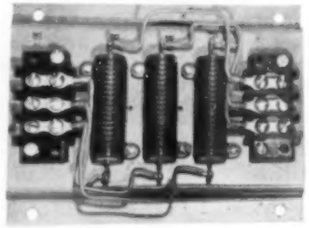


Figure 2

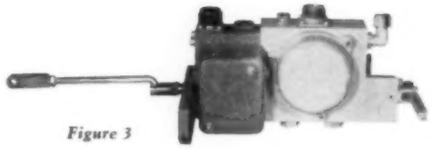


Figure 3

Figure 4

Figure 6

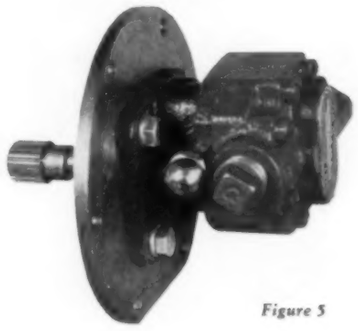


Figure 5

through the governor actuator system can be maintained entirely free of bulky foreign particles. For long trouble-free service it seems best to keep the governor oil free from other uses.

RECOVERY TIME—Typical recovery time to steady state condition on full-load transients (no load to full load) is less than one second for lightweight, high-speed (1200 rpm and 1800 rpm) generator sets; for heavy, low-speed sets recovery time is proportionately faster than with conventional governor.

FREQUENCY DEVIATION—Typical control of frequency deviation on full-load transient is less than 1.5% of base frequency for lightweight, high-speed (1200 rpm and 1800 rpm) generator sets; for heavy, low-speed sets frequency deviation is proportionately less than with conventional governor.

STEADY STATE REGULATION—Controls generator output frequency at any steady state condition from no load to full load to within ±¼ of 1%.

UNBALANCED PHASE LOADING—Electric governor performs equally well with balanced or unbalanced phase loading . . . amount of unbalance has no effect so long as voltage regulation is within limits (±2%). A ±2% voltage regulation is required only during steady state. Recovery time and frequency deviation as stated above for transient conditions are accomplished in conjunction with fast-acting, magnetic amplifier-type voltage regulators. With slower type voltage regulators transient recovery and frequency deviation are somewhat greater. Electric governor stability is unaffected.

SINGLE-UNIT AND PARALLEL OPERATION—The electric governor is unique in that it operates with zero speed regulation (isochronous) in single-unit AND IN MULTIPLE-UNIT PARALLEL operation. Therefore, the same precise regulation is available from two or more generator units in parallel as from single-unit operation. Conventional-type governors require speed regulation of 3 to 5% for parallel operation. By customer demand, the electric governor has built-in adjustable-speed regulation to 5.0% to permit operation in parallel with conventional governors when required. This feature makes it possible to replace existing conventional governors in an orderly and systematic manner.

WESTINGHOUSE ELECTRIC GOVERNOR—COMPONENT GROUPS AND ORDERING DATA

60/50 cps and 400 cps Types

Component	Model	Working Force Foot Lbs.	Pump Speed Range RPM	Eng. Gen. Size Range Approx.	Load Limit	Adjustable Speed Droop 0-5.%
Control Unit	Mark I-A					yes
Auxiliary Panel	Mark I					
Actuator	Mark I-E	5 or 8 max.		Up to 500 KW	no	
Hyd. Pressure Sup.	Mark I		900-3600			
Tank (Hyd. Fluid)	Mark I					
Control Unit	Mark I-A					yes
Auxiliary Panel	Mark I					
Actuator & Hyd. Sup.	Mark I-D	32 max.	300-1200	Above 500 KW	yes	

Customers should supply the following information with their inquiries:

Generator Data: Current transformer ratio ..... Frequency ..... Volts ..... KW ..... Power Factor ..... Generator RPM ..... Engine RPM .....

..... Method of providing 3 phase, 120 volts in phase with line current at unity PF to electric governor .....

Throttle Actuator Data: Total degrees throttle rotation ..... Degrees throttle rotation no load to full load ..... Direction of rotation of throttle shaft to

open throttle (CW or CCW) ..... (looking at the end of throttle shaft.) Torque required to start throttle rotating .....

Hydraulic Supply Data: Pump drive RPM ..... Pump drive rotation (CW or CCW) .....

FARRIS PICKERING

HYDRAULIC RELAY AND MECHANICAL GOVERNORS

TYPE 3300 ISOCHRONOUS GOVERNORS—The type 3300 Farris-Pickering hydraulic governor is adaptable to diesel engines for practically all industrial applications. It is available for constant or variable speed service.

The governor features full work capacity with complete regulation over the full range of speed settings. Isochronous or speed-droop characteristics are obtainable by manual adjustment. Adjustments provided include speed changer, steady state speed regulation, first compensation relay, second compensation timing valve, rate of response and load limit throttling. A fail-safe flexible drive dampens speed variations without affecting performance.

While maintaining the time-proven reliability of the older models the new governor has been simplified, streamlined and made more sensitive. Simplicity has been achieved both in its external and internal construction. The internal linkage has been designed to minimize the number of moving parts and wear points. This simplified construction permits easy assembly and maintenance with no special tools required.

Tolerances in the governor are necessarily close to get a high degree of sensitivity. Precision has been maintained although there are incorporated many simple inexpensive hardware parts which if necessary could be obtained from a local source. All individual parts, are interchangeable in the field. Because these parts and assemblies can be so readily interchanged both at the factory and in the field and without handfitting, conversion, replacement or repair costs are extremely low.

TYPE 3300 SPECIFICATIONS

Rated Work Capacity	123 in-lbs.
Stalled Work Capacity	176 in-lbs.
Rated Throttle Shaft Torque	159 lb-in.
Stalled Throttle Shaft Torque	227 lb-in.
Throttle Shaft Rotation	42 degrees
Optimum Constant Speed	1200 R.P.M.
Constant Speed Range	550-1200 R.P.M.
Variable Speed Ratio	4:1
Variable Speed Range	400-1600 R.P.M.
Speed Droop Adjustment	0-8%
Drive Shaft Rotation	Reversible
Drive Shaft	Splined or Gear Type
Automatic ShutDown	Solenoid
Speed Changers:	
(1) Constant Speed	Knob
(2) Variable Speed	Lever
(3) Switchboard	Electric Motor
(4) Automatic Control	Pneumatic
Over All Height	13-5/16 in.

TYPE 3700 ISOCHRONOUS GOVERNORS—The Farris Pickering type 3700 hydraulic governor has ample capacity to govern the largest engines. The governor can be supplied with various types of speed changers to suit operating requirements. Provision for switchboard control of the speed setting is by means of a reversible electric motor mounted directly on and included with the governor. Motors are universal for ac or dc and supplied for either 110 or 220 volts as specified.

Manual control of the speed setting is also provided in the form of a knob mounted on the gov-

3300K Knob adjustable speed control

3300M Motor control speed adjustment for remote operation

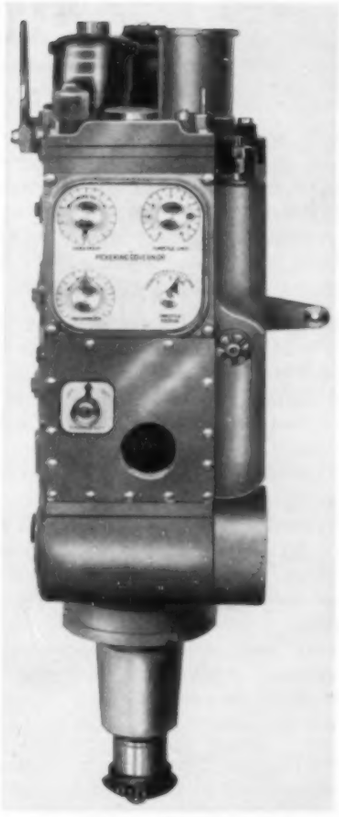
3300L Lever speed control adjustment ½" spline std.

ernor control panel. Either means may be used at any time without interference of the other. Additional knobs are provided for manual setting of the Speed Droop and Throttle Limit. A pointer located on the control panel and operated by the governor indicates the degree of governor stroke and consequently degree of throttle opening employed under all operating conditions. A readily accessible means of adjusting the return time of the governor to correspond with that of the engine and generator (i.e. time required to return to synchronous speed after a change in load occurs) is also provided.

In operation speed changes are momentary and entirely self correcting. Synchronous motor electric time clocks operating on the frequency output controlled by these governors are readily held to a time accuracy of less than 10 seconds in 24 hours. 3700 type governors in other models are also available for variable speed service wherever positive control of speed, via the governor, is indispensable to correct operation of the engine.

This type governor is usually supplied with a speed changing lever. The type 3700 features a flexibility of controls that enables the governor to be easily adapted to various requirements. Any one or combination of the following features may be provided if desired:

1. Motor control of synchronizer.
2. Speed droop control, hand operated.
3. Throttle limit control, hand operated.
4. Emergency hand trip.
5. Automatic Shutdown to protect against:
   a. Low pressure in engine lubricating system.
   b. Low pressure in governor oil system.
   c. Overspeed of governor.
6. Electrically responsive shut down for use with any number of remote protective devices.



Type 3700 Isochronous governor

TYPE 3700 SPECIFICATIONS

Rated Work Capacity	111 in-lbs.
Stalled Work Capacity	157 in-lbs.
Rated Throttle Shaft Torque	400 lb-in.
Stalled Throttle Shaft Torque	572 lb-in.
Throttle Shaft Rotation	16 degrees
Optimum Constant Speed	900 R.P.M.
Constant Speed Range	375-1200 R.P.M.
Variable Speed Ratio	3:1
Min. Speed of V.S. Range	250 R.P.M.
Max. Speed of V.S. Range	1200 R.P.M.
Speed Droop Adjustment	0-8%
Over All Height	22-½ in.

TYPE 2600 MECHANICAL GOVERNORS–The type 2600 governor is designed for use on medium sized diesel and gas engines. The governor has ample capacity to control a multiple installation of fuel injection pumps, a common rail system of injection or any of the conventional types of fuel delivery. It is also being used for throttle control of steam engines and turbines. The governor is capable of very accurate speed regulation and is giving exceptional satisfaction under many conditions of service including compressors and electric generating service. The governor can be supplied in many variations of construction, including a built in flexible drive and variable speed construction.

Type 2600 Mechanical speed droop governor

TYPE 2600 SPECIFICATIONS

Work Capacity	20 in-lbs.
Torque Capacity	70 in-lbs.
Constant Speed Range	500-1800 R.P.M.
Variable Speed Range	500-1440 R.P.M.
Throttle Shaft Rotation	16 Degrees

TYPE 2200 MECHANICAL GOVERNORS–The type 2200 governor is a small mechanical flyball type of governor which is capable of very accurate speed regulation. This governor is used extensively as the main governor on small engines and is also used as an overspeed governor on larger engines. This type is being used successfully on diesel, gas, gasoline engines and on steam turbines in service which vary from pump and compressors to electric generating sets. The variable speed type is used extensively for marine use and where the service conditions require a variable speed governor. The type 2200 governor can be supplied with a permanently attached flexible drive which has proven to be exceptionally efficient in absorbing cyclic speed variations. The governor is usually supplied with the mating member for the governor drive shaft of the engine.

TYPE 2200 SPECIFICATIONS

Torque Capacity	11 in-lbs.
Constant Speed Range	500-2400 R.P.M.
Variable Speed Range	500-1440 R.P.M.
Throttle Shaft Rotation	16 Degrees
Tongue Type Drive Shaft	Standard

TYPE 3300P–Pneumatic motor for speed adjustment. Remotely operated. (Not illustrated.)

Type 2200 Mechanical speed droop governor

WOODWARD

HYDRAULIC GOVERNORS

WOODWARD Governor Company, Rockford, Illinois, is one of the world's oldest and largest manufacturers of hydraulic governors exclusively. Woodward governors for diesel, gas and dual fuel engines, steam and gas turbines are all manufactured under controlled atmospheric conditions in the modern Woodward Governor Company plant at Rockford, Illinois.

Diesel engines are now used in such a variety of services and with so many special requirements that the science of governing them has become extremely complicated. As a result, Woodward builds a wide variety of governors and auxiliaries to meet special requirements of particular installations. Although differing in external appearance, in function and in work capacity, they all make use of the same basic centrifugal speed measurement and single valve hydraulic relay principles.

Selection

The choice of a governor for any application depends on two things . . . the control requirements and the work required from the governor to move the fuel control of the engine. The work required is equal to the distance the fuel control must be moved multiplied by the force required to move it at the point of greatest resistance. This work is then expressed in kilogram-meters or foot-pounds.

Woodward governors are rated in stalled work capacity:

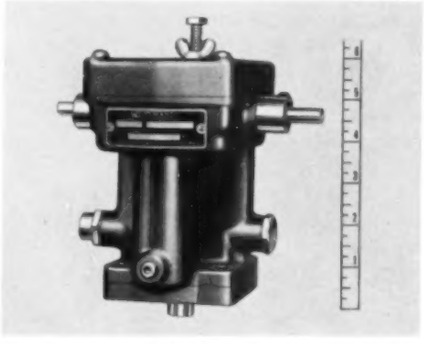
Type	Stalled work capacity in foot-pounds
SG	½ or 1
PSG	4
UG8	8
UG32	32
PG	12, 17, 29 or 44

For satisfactory operation the stalled work capacity of a governor should be 50 per cent greater than the work required to move the fuel control of the engine it is governing. If less than the full travel of a governor is used, its work capacity is proportionately reduced. It is desirable to minimize transient speed variations at the time of a load change. Where the work required is less than the capacity of the governor these transients can be minimized by using less than the full travel of the governor in moving from no-load to full load. Because the matter of stability also enters into this consideration, it is desirable to have engine characteristics and load data together with complete information regarding the work required to determine the proper governor for your application.

A governor is said to have speed droop (steady state speed regulation) if there is some reduction in speed after load is picked up by the engine. A governor is considered isochronous when it causes the engine to run at the same speed regardless of the load, within the capacity of the engine. Except for type SG (Simple Governor), all Woodward governors are isochronous. However, speed droop is required in a governor for some special purposes, such as dividing load between alternating current generating units. When required, a special mechanism is provided to give this characteristic.

Practically all Woodward governors may be furnished with auxiliaries to shut down the engine in case of lubricating oil failure, to limit the load, as for instance when a locomotive engine must have its fuel restricted when it goes to high altitudes and many other auxiliary devices. In addition to auxiliary devices there are many special arrangements possible to meet unusual or special requirements in governing diesel engines for almost any application and to permit simple adaptation to the engine. Simple modifications of standard governors will often meet these special requirements. When supplied with complete data, Woodward makes definite recommendations and, in some cases, offers a choice of governors as well as makes the necessary calculations to give the expected performance.

SG GOVERNOR: This governor is used for smaller engines in the range from 50 to perhaps 150 horsepower where it is desired to have better governing than may be obtained from a simple mechanical governor, but where isochronous operation is not necessary. This governor uses speed droop for stability . . . commonly a speed droop value of 3 or 4 per cent. This Woodward type governor is more stable than a simple mechanical governor and will give smaller speed deviations for a given load change. This one type of governor requires a return spring in the direction to shut off fuel.

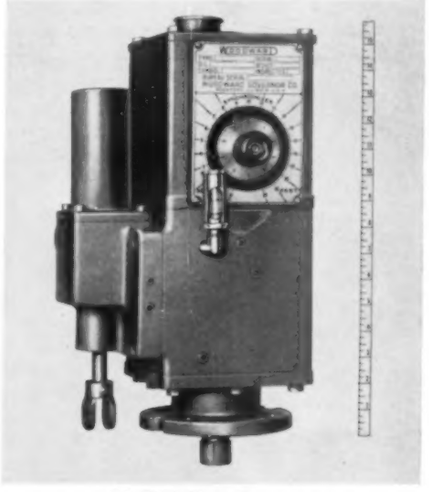


SG Governor

PSG GOVERNOR: This PSG governor was developed to meet certain specialized applications where small size, light weight and lower cost are more important than convenience in adjusting. The PSG is similar to the SGX, but is slightly larger, and has a greater work capacity. It is isochronous or it may be set to operate with speed droop. This type of regulation is adjustable internally from zero to 10 per cent for full terminal shaft travel at maximum speed. This governor can be obtained with externally adjustable speed droop.

PSG Governor

PG GOVERNOR: This governor with dial or lever type speed adjustment is used for a large variety of rather specialized applications. The lever type speed adjustment is often used where it is desired to change the speed setting rapidly. Therefore, governors for locomotive, ship propulsion, pumping and similar services usually require the lever type speed adjustment. Control is obtained by mounting a lever on the projecting speed adjustment shaft. The PG dial type governor is illustrated showing the speed adjusting knob, pointer and calibrated dial of the speed adjustment control.



PG Dial Type Governor

The upper half of the governor containing the speed adjusting mechanism may be turned to any of the four 90 degree positions to facilitate easy mounting. The servomotor which is bolted to one side of the governor, may also be turned to any of the four 90 degree positions, or with special adapter, may be mounted at intermediate angles. Another advantage is that the servomotor rod may be arranged to move in either direction to increase fuel.

The PG governor is normally isochronous with an improved compensating (temporary speed droop)

system and simplified construction. As with all Woodward governors, many special auxiliary devices are available for the type PG. It may be furnished with a shutdown solenoid for remote engine stopping. A series-wound motor for remote speed setting is available. On somewhat rare occasions when the characteristics of this governor are preferable to others and speed droop is wanted, a special arrangement can be furnished.

PG-PL Governor

PG-PL GOVERNOR: The Woodward type PG-PL governor is one of many special purpose variations of the basic PG governor. The PG-PL, an isochronous governor, was first used on pipelines but has since found application on all types of diesel engines driving pumps or compressors. Type PG-PL governors can be used for manual speed setting from a remote point when electric speed setting cannot be used and for automatic control in connection with air instruments.

When provided with a suitable air controller, the PG-PL governor will run an engine at any speed necessary to maintain constant output pressure, suction pressure, differential pressures, flow, suction pressure with an override if discharge pressure becomes excessive, and any other quantity that can be measured by air controllers. The governor receives an air pressure signal, either from one of the many standard air controllers on the market, or from a simple pressure regulator for manual speed setting at the control panel. The governor will cause the engine to run at a definite speed for each air pressure. Air pressure versus speed relationship is accurately set at the factory but a change can be made in the field, if neccessary.

Most common control air pressure ranges are 3-9, 3-15, 9-15, and 5-25 psi. Air pressures up to 60 psi can be accommodated. The desired governor speed range usually falls between 250 and 1050 rpm, but a low of 150 rpm and a high of 1500 rpm can be obtained if required. Governor speed changes of 8—120 rpm per psi of control-air pressure change can be effected. Woodward engineers should be consulted on application requirements exceeding the above ranges. This PG-PL governor may be arranged to increase the engine speed setting either where control-air pressure is increased or when control-air pressure is decreased.

PG GOVERNOR FOR RAILROAD LOCOMOTIVE UNIT: This version of the PG governor is an electro-hydraulic type which sets the speed through the energizing of various combinations of solenoids. This is accomplished through movement of the locomotive engineer's control lever which makes a series of electrical contacts. This electric control permits coupling any number of locomotives together with the engines on each running at very close to the same speed. For single locomotives, such as are used in switching and on some passenger trains, a pneumatic speed setting is used.

PG Governor for Railroad Locomotive Unit

At any particular speed a diesel engine will have the lowest fuel consumption per horsepower-hour at one particular load. The load control mechanism in the electro-hydraulic and pneumatic-hydraulic governors adjusts the exciter rheostat of the locomotive generator as required to cause the engine to deliver exactly the designed horsepower for each operating speed. This results in a very worthwhile fuel economy. Where the power dissipated in the rheostat is small, both it and the vane servomotor are furnished with the governor and mounted on one side of it. This same governor with very minor modifications has been used to control the pitch of adjustable pitch ship propellers to obtain the desired engine loading for each engine operating speed.

The relationship of speed, load and minimum fuel consumption is usually a linear relationship between operating speed and load. Where a non-linear relation is desired, a cam may be provided to give it.

In some applications, particularly in direct reversing marine engines, where it is desirable to have the governor move to the full fuel position instantly when the engine is started, a booster servomotor is used. Starting air is admitted to the booster at the same time it is admitted to the engine. The booster furnishes a supply of oil to the governor until the governor's pump builds up pressure.

UG8 and UG32 GOVERNORS: The dial type UG-8 governor is most commonly used for controlling engines driving electric generators. It is an isochronous governor, but has adjustable speed droop that is regulated manually by means of a knob from zero to any reasonable value for load division. It also has a load-limit knob which can be set to any desired point and will prevent the engine from carrying more than a certain amount of load. It can also be used to manually shut the unit down. This eight foot-pound governor has sufficient work capacity to operate the fuel control of all but the largest engines. For very large engines the 32 foot-pound UG32 governor is used.

UG8 Governor

Either of these governors may be furnished with a split-field, single phase, series-wound speed-adjusting motor in any standard voltage up to 220. The motor will operate on direct or alternating current. The maximum range of speed adjustment of the dial type UG8 governor is approximately 2.2 to 1, which is more than enough for generating sets. Where a wider range of speed adjustment and rapid speed setting is required, as on simple locomotives, some ship propulsion engines, etc., the lever type UG8 is used. Its speed is set by rotating the speed control shaft through some 20 or 30 degrees. A speed range as high as 4 to 1 may be obtained. The UG8 lever governor may be obtained with internally adjusting speed droop. A lever type UG32 is also available and speed droop may be included in this governor.

UG8 and UG32 Governors Drive Shaft Speed Range

	Stalled Work Capacity ft. lbs.	Maximum Usable Work ft. lbs.	Terminal Shaft Rotation (Fuel Control) degrees	Governor Drive Shaft Speed Range rpm	Gov. Drive Shaft Speed For Constant Speed Use rpm
UG8-Dial	8	5	42	500-1500	1200-1400
-Lever	8	5	42	375-1500	
UG32-Dial or Lever	32	25	38	350-1000	800- 950

MARQUETTE

HYDRAULIC RELAY GOVERNORS

THE Curtiss-Wright Corporation, Marquette Metal Products Division, manufactures hydraulic-relay speed governors and hydraulic-overspeed trips for Diesel, gas, and dual-fuel engines. All models are self-contained governing units built to the highest standards of precision and interchangeability. Various models are used as standard governing equipment by builders of medium and large engines for AC and DC generating units, pumping and compressor installations, marine and rail service where precise and stable engine speed control is required with maximum reliability.

Simplicity of design and construction is a feature of Marquette governing equipment. Three precision-built elements are the basis of all governors. The first is a speed-sensitive element made up of hardened one-piece ball arms carefully balanced and mounted on hardened, frictionless, knife edge pivots and rotated by a drive shaft rubber-damped from undesirable engine vibrations. The ball arms are located within a cup that keeps them free from fluctuating governor sump oil at the same time lubricating the pivots with a mist of oil. This cup serves as an easily cleanable centrifuge which continuously maintains governor oil dirt free. The ball arms rotate the balanced pilot valve thereby removing a troublesome source of static friction. The centrifugal force of the rotating ball arms is counterbalanced by a specially designed conical speeder-spring. This allows the speeder-spring adjustment to be approximately linear with speed setting.

The second element, a power source, is a hydraulic double-acting power piston providing positive power in both directions for actuating the fuel control system of the engine. Pressure oil for governor operation is stored in two large capacity spring-loaded accumulators supplied by a gear pump mounted in the base of the governor. The pump is provided with four ball check valves to permit the governor drive to be rotated in either direction while always delivering a positive oil pressure.

A stabilizing mechanism is the third basic element. Stable operation of hydraulic-relay governors depends upon power piston action in a manner to cause either temporary or permanent speed droop. All Marquette governors are equipped with a simple hydraulic compensating system to provide temporary speed droop. This enables stable operation at a fixed or isochronous speed. Compensation occurs by hydraulic action of the power piston upon the rotating compensating receiving piston, spring-connected to the lower end of the pilot valve, thereby modifying the speeder-spring force. An adjustable leak-off determines the rate at which this temporary droop or compensating action is removed. This single compensating adjustment mates any governor with its engine for stable speed control. Permanent speed droop required by engines sharing electrical or mechanical load is supplied by a simple power-piston-operated mechanism within the governor. Speed droop is normally adjustable from 0 to 10 per cent. Depending upon the engine builder's requirements, this adjustment is made by an external knob or screw adjustment inside the governor.

The many types of hydraulic governor-controlled engines and the varied operating loads require modifications and additions to the basic governor. Marquette governors are versatile in their adaptation to such modifications. For example, vertically-acting and horizontally-acting power cylinder as well as terminal shaft output connections are available in a variety of work capacities for either right or left hand engines. Several drive shaft and base arrangements are available as standard options to meet installation requirements.

Many additions for special installation requirements are also available. These usually modify the normal governor action to meet special requirements or to provide remote control of various governor adjustments.

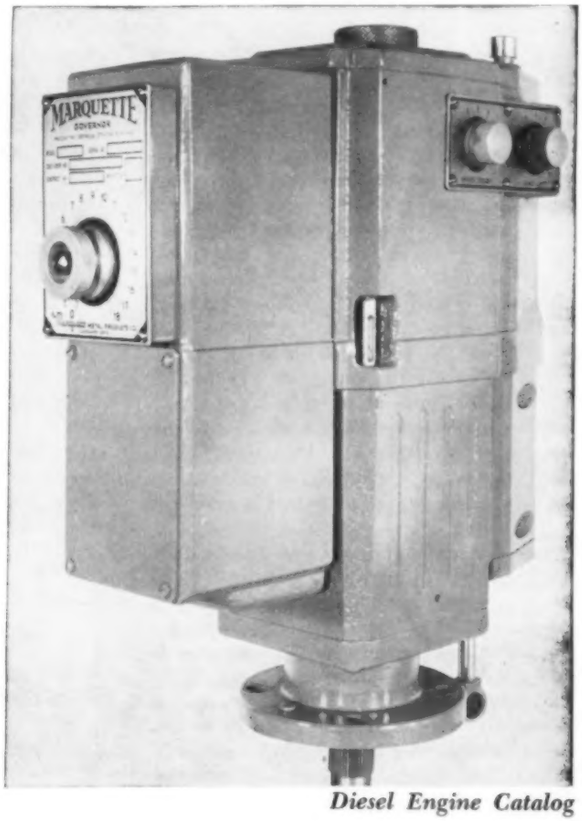
The following are some examples of proven additions:

Speed-Setting Adjustments—Many installations require accurate remote speed adjustment. An electric synchronizing motor or an air-pressure operated diaphragm are supplied for this purpose. Certain installations require speed setting adjustment using a very small adjusting force. In these governors a hydraulic power head converts the weak speed setting signal into accurate governor speed settings.

Rapid Hydraulic Shutdown—Rapid motion of the

Model B-132 hydraulic relay governor.

Model B-135 hydraulic relay governor.



power piston to a positive shutdown position requires an almost effortless actuation of a balanced hydraulic shutdown valve to which, for hand shutdown, a button on the governor cover is connected. For remote shutdown control (as by solinoid or pressure diaphragm) the same valve is actuated.

Hydraulic Power Piston Limit—The power piston stroke limiter operates through the hydraulic shutdown valve. An adjustment knob positions a cam stop for accurate power piston or load limit. Power piston limiting for smooth starting purposes and complete shutdown are also made possible with this control. A separate ballhead is built in some governors to control the shutdown valve in such a manner as to limit power piston motion as a function of actual engine speed.

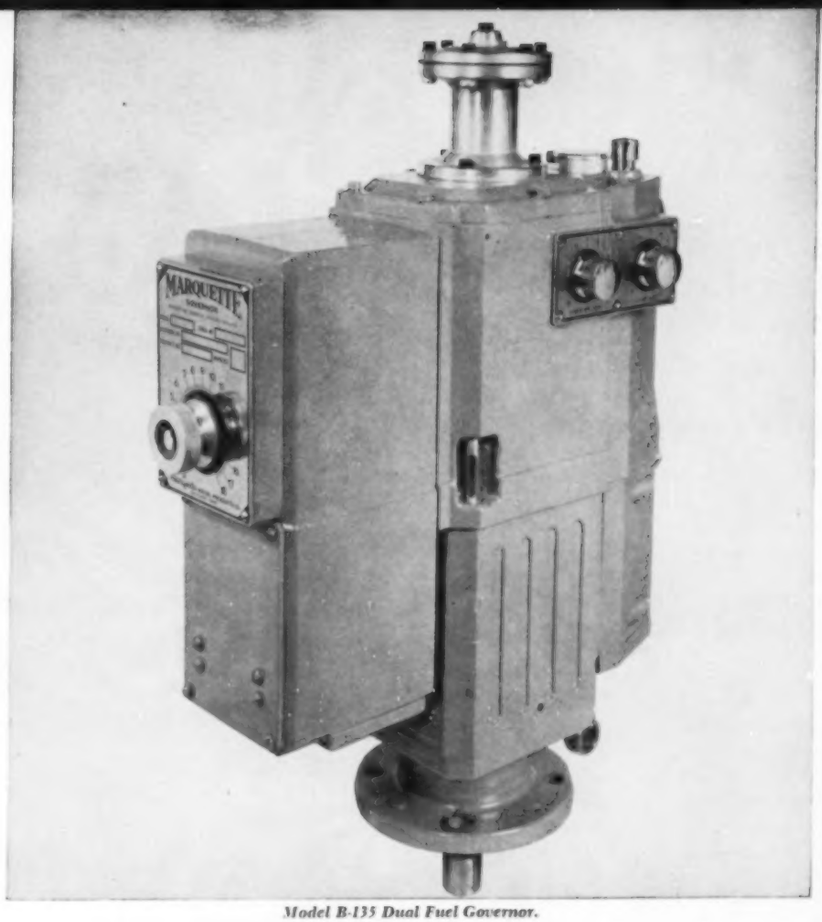
Safety Devices—To protect the modern engines against damage from lubricating oil failures, overheating, and over-speeding, automatic shutdown for any of such failures is necessary. Protective shutdowns are built into the governor as required by the engine builder to provide the protection needed for those failures.

At present, two models of special Marquette overspeed protective governors are built. One unit is completely self-contained. It causes motion of a power piston when an overspeeding condition exists and retraction when the engine speed has dropped to a predetermined safe value. This power piston may be used mechanically to operate any shutdown mechanisms, for example, fuel or air supply shut-off devices.

The other type overspeed unit consists of a speed sensitive ballhead operating a pilot valve which in turn controls the hydraulic output of a self-contained shutdown oil supply from a gear type pump. The hydraulic output of this type unit may be used to supply a remote hydraulic shutdown device. The unit may be adjusted for complete shutdown requiring resetting or for automatic resetting at a predetermined safe speed.

Marquette governor parts are designed, tooled, and manufactured to insure complete interchangeability for simplified service. Commercial governor castings are fine-grained Meehanite. All valves, valve sleeves, pistons, and shafts are nitrided Nitralloy. All links, levers, and exposed parts are plated for added protection. All external or installation dimensions such as drive shaft, governor base, power piston connection, and terminal shafts conform to standard governor practice.

Often the requirements of governors change with engine developments, modernization programs, and changes of loads connected to the engine. To meet new governor requirements, close contact is maintained with engine builders and engine operators. Of prime consideration in governor development are designs that will be readily adaptable to the modernization of existing Marquette governing equipment. In this way all Marquette governors can be maintained at a high level of governor efficiency in keeping with current standards of governing practice.



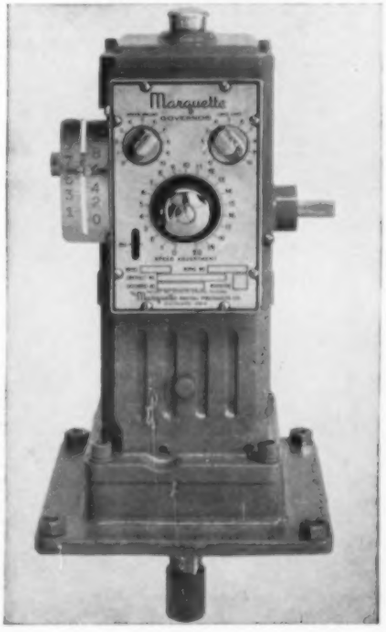
Model B-135 Dual Fuel Governor.

TYPICAL MARQUETTE HYDRAULIC GOVERNORS

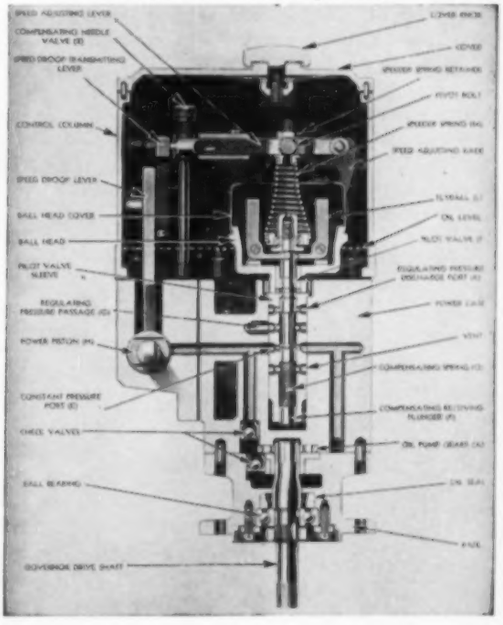
Model Number	Type Output	Output Motion	Method Speed Adjustment	Drive Shaft Speed Range (RPM)	Special Features
B 101	Horizontal Power Cylinder	1"	Serrated Shaft	300-1200	
B 132	Horizontal Power Cylinder	1-¼"	Serrated Shaft	300-1200	Speed Droop
B 135	Vertical Power Cylinder	1-¼"	Dial and Sychronizing Motor	300-1000	Speed Droop Load Limit
B 149	Horizontal Power Cylinder	1-¼"	Dial and Sychronizing Motor	300-1200	Speed Droop Load Limit
F 200	Serrated Terminal Shaft	48°	Dial	300-1400	Speed Droop Load Limit

Governors are supplied with work capacities of 5 to 32 ft. lbs. as required by the particular installation.

Model F 211 Governor.



Cross section of Model B-117 governor.



MASSEY

CURTISS-WRIGHT CORP.
MASSEY MACHINE CO.
DIVISION

MASSEY TYPE HP

Hydraulic Isochronous Governors are built in several models, all interchangeable on mounting and throttle linkage, for various applications on medium to large size engines:

SINGLE DIAL:
For engine driven pumps and compressors.

TWO DIAL WITH SYNCHRONIZING MOTOR:
For generator service.

SPEED & PRESSURE MODEL:
For controlling engine speed through the governor from suction pressure or discharge pressure of engine driven pumps or compressors. These are used on pipelines and in gasoline plants, refineries and chemical plants.

LEVER CONTROL MODEL:
For marine and locomotive service.

SPEEDS:
375 to 1500 RPM.

WORK CAPACITY:
HP-1 150 inch-lbs.
HP-4 400 inch-lbs.

TERMINAL SHAFT MOVEMENT:
HP-1 33 degrees.
HP-4 47 degrees.

HYDRAULIC SYSTEM:
Self contained hydraulic system with its own pump and accumulator.

ADVANTAGES:
Very simple mechanically and unusually stable in operation because of direct acting hydraulic system of compensations, without mechanical linkage, using force balance principle.

MASSEY TYPE E

Hydraulic Isochronous Governors for small engines use the same basic principles and use engine lube oil for the hydraulic medium. They are available in the same types of models listed for HP Governors.

SPEEDS:
375 to 3600 RPM.

WORK CAPACITY:
23 inch-lbs. with 40 P.S.I. Oil.

Type-H.P.—Synchronizing Motor.

Type-H.P.—Speed and Pressure Control.

Type E—Isochronous.

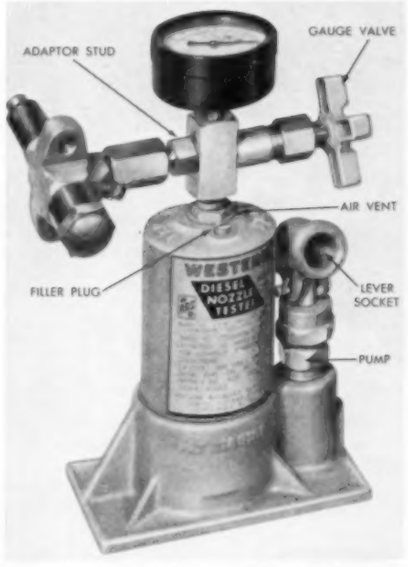
Type-H.P.—Single Dial.

PORTABLE UNIVERSAL NOZZLE TESTER

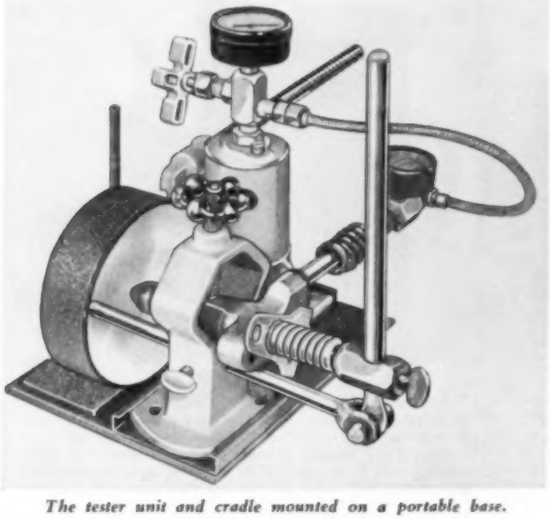
WESTERN RAILROAD SUPPLY COMPANY

THE Western universal diesel nozzle and injector tester was formerly a product of the Buda Division, Allis-Chalmers Mfg. Co., and was included in the group of Buda products purchased by Western Railroad Supply Company. We claim it is the only diesel nozzle tester available that is both universal and portable. This precision hydraulic instrument is built for accuracy in testing all makes of diesel engine nozzles or injectors. Rugged and simple in construction, this device requires no technical skill for its proper use. Any mechanic or diesel engine operator can follow the simple printed instructions that come with every unit in measuring injector opening pressures, determining accurately the adjustments needed, checking spray patterns for uniformity and detecting other fuel-consuming or power-robbing conditions. These irregularities include sticking needle valves and leakage around valve seats. Weighing less than 10½ lbs complete, including the all-steel carrying case, one adaptor and removable 12 in. steel handle, the unit is easily carried to road or field service calls as well as within the diesel maintenance shop. The carrying case dimensions are 5⅝ in. x 7½ in. x 11½ in. A high quality hydraulic pressure gauge, 3 11/16 inch dial, 3,000 psi capacity with 100 lb graduations, is standard equipment on each tester. Gauges of 5,000, 7,500 and 10,000 psi capacity are also available. A gauge valve permits user to shut-off the gauge when making tests not requiring pressure readings, thus conserving the life of the gauge and maintaining its accuracy.

Supplementing the Nozzle Tester is an additional portable carrying case containing a complete assortment of adaptor fittings for all nozzles, special cradle and "popping" device, extra pressure gauge, risers, spray pan, high pressure lines, fittings, etc. . . . everything needed for on-the-spot testing of any nozzle or injector, regardless of make or model. A comprehensive instruction manual is supplied with each testing unit. It details how to set up and operate the basic tester and all accessories, how to interpret spray patterns and identify symptoms of improper adjustment, wear or corrosion. It contains a complete compilation of diesel fuel injection data. Western Universal Nozzle Testers are available in a variety of sets—"Special," "Semi-Universal," and "Universal." "Special" sets consist of the basic testing unit and those few adaptors required for one or two makes and models of small nozzles. The "Semi-Universal" sets are made up of the basic testing unit plus the cradle, "popping" device and other accessories required for handling larger nozzles and unit injectors along with selected adaptors for a limited number of makes and models. With the "Universal" set comes a complete assortment of adaptors, thus providing for testing of any make or model of injector. As new injection systems are developed, adaptors are designed and made available to users in a continuing program to keep this equipment currently universal. The basic unit can be adapted to test valves, castings, controls, brakes, radial gasoline engine injectors, presses as well as other compact hydraulic systems.



The nozzle tester unit with nozzle in place for testing.



The tester unit and cradle mounted on a portable base.

The two carrying cases; one for the tester, the other for cradle and accessories.

YOUNG RADIATOR

COMPLETE HEAT TRANSFER FOR DIESELS

YOUNG Radiator Company has over 3 decades of experience in the heat transfer field and has pioneered many developments in Diesel cooling. Every detail of Young cooling systems is carefully designed and engineered by engineers who thoroughly understand Diesel engines and who are ready to solve your particular problem. Young units combine maximum efficiency with clean, remarkably compact design.

Young Radiator Company offers a complete line of heat transfer products to satisfy all cooling needs, from the smallest Diesel engine to the largest multiple installation. Units of all types are available, to cool air, water, gases, and lube oil. The basic heat transfer surfaces can be supplied in a very wide variety of materials, shapes and designs. All types of accessories-fan assemblies, bearings, gear boxes, louvers, controls, etc.—are also available. Combining the wide range of Young designs, basic surfaces, and accessories makes it possible to meet any cooling requirements.

SUPERCHARGER INTERCOOLERS—Intercoolers can markedly increase efficiency even in engines where their use is not mandatory. As air leaves the supercharger it is efficiently cooled, enabling a greater mass of air to enter the cylinders than would be possible without intercooling. Thus the power of the engine is increased without an increase in fuel consumption. These units effect maximum heat transfer with minimum loss of pressure.

JACKET WATER COOLERS—These rugged units are built for long, trouble-fee life and heavy duty cooling. Steel frames built with Young patented "Mono-Weld" construction are typical of their sturdiness.

SHELL AND TUBE HEAT EXCHANGERS—These Heat Transfer units combine maximum efficiency and maximum compactness. They are available with fixed bundles or with removable bundles for extra-easy maintenance and repair. Single, two and four pass models.

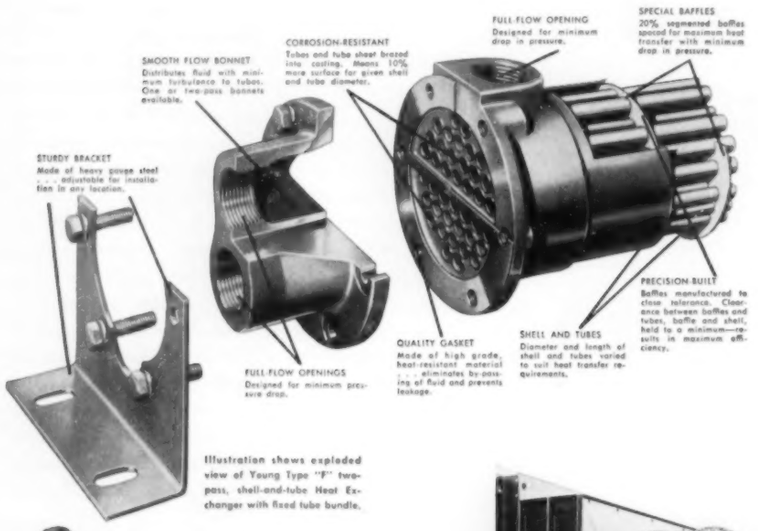
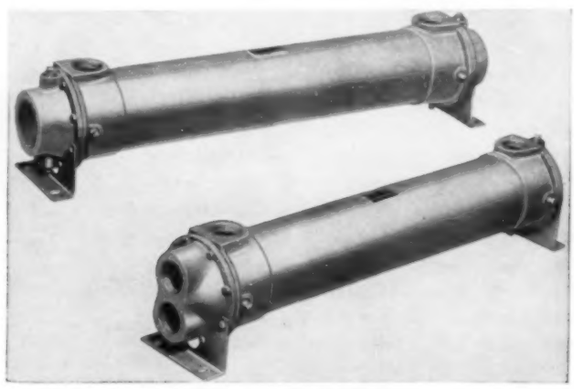
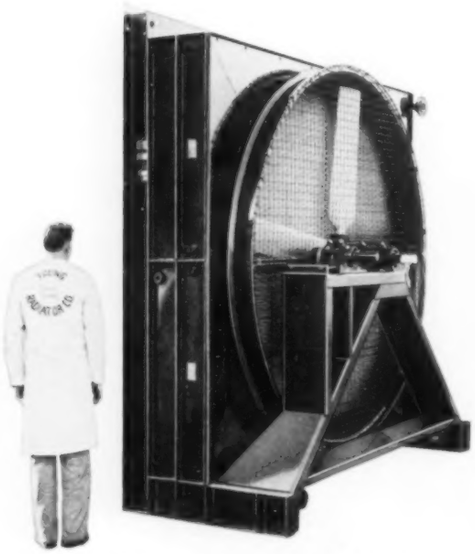

SMOOTH FLOW BONNET
Distributes fluid with minimum turbulence to tubes. One or two-pass bonnets available.
CORROSION-RESISTANT
Tubes and tube sheet brazed into casting. Means 10% more surface for given shell and tube diameter.
FULL-FLOW OPENING
Designed for minimum drop in pressure.
SPECIAL BAFFLES
20% segmented baffles spaced for maximum heat transfer with minimum drop in pressure.
STURDY BRACKET
Made of heavy gauge steel . . . adjustable for installation in any location.
PRECISION-BUILT
Baffles manufactured to close tolerance. Clearance between baffles and tubes, baffle and shell, held to a minimum—results in maximum efficiency.
QUALITY GASKET
Made of high grade, heat-resistant material . . . eliminates by-passing of fluid and prevents leakage.
SHELL AND TUBES
Diameter and length of shell and tubes varied to suit heat transfer requirements.
FULL-FLOW OPENINGS
Designed for minimum pressure drop.

Illustration shows exploded view of Young Type "F" two-pass, shell-and-tube Heat Exchanger with fixed tube bundle.



Young Shell and Tube Heat Exchangers are used extensively for exchange of heat in liquids and gases, and as oil coolers for gas or Diesel engines, torque converters, hydraulic presses and reduction gears and similar applications. Available in single, two-pass and four-pass design in a wide range of capacities.

Mono-Weld ® Radiators made by Young for Diesel locomotives and stationary Diesel applications provide maximum heat transfer with minimum space requirements. Simple, low-cost Mono-Weld design features a solid core flush with welded steel tanks and heavy gauge steel side members. The units are built to withstand severe shock and perform efficiently under all conditions.



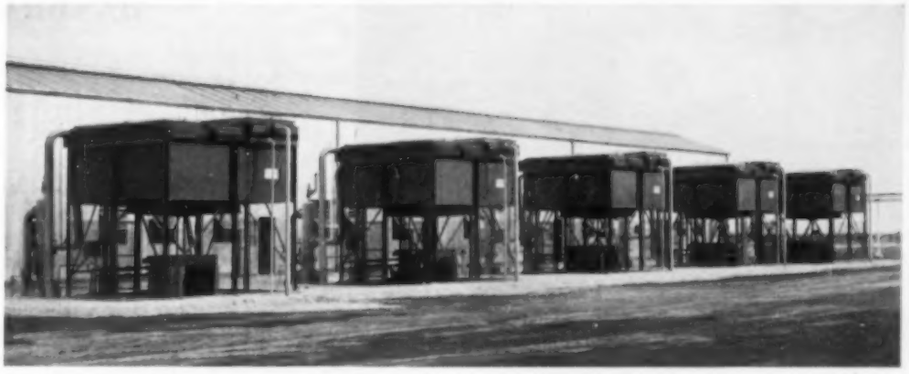
Young Jacket Water Coolers combine high cooling capacity with low initial cost and low power consumption. This engine-driven unit is used to cool both jacket water and lube oil. It can be adapted for gas cooling by insertion of another coil. Young fabricated type header design permits full liquid flow through sections.

High efficiency fans on Young Jacket Water Coolers reduce horsepower cost. Core design minimizes resistance to airflow. This electric motor, belt-driven unit for water cooling only is engineered to meet the most exacting requirements and built to last the lifetime of the power plant.

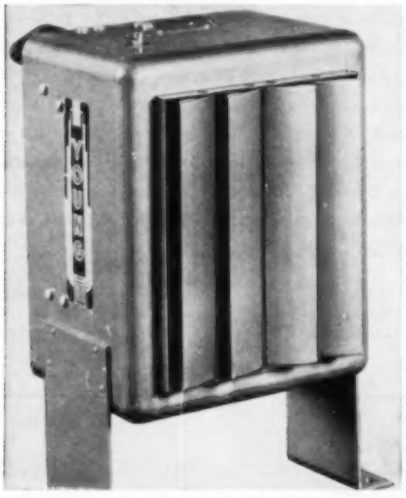
EVAPORATIVE COOLERS—In warm, dry climates, or in places where warm, dry conditions can be made to prevail, evaporative coolers greatly increase the efficiency of heat transfer surfaces by taking advantage of the very large loss of heat in evaporation.

ENGINE COOLING RADIATORS—Young radiators are available for every Diesel use, from cooling tractors to stationary power units and locomotives. A wide range of designs meets all needs.

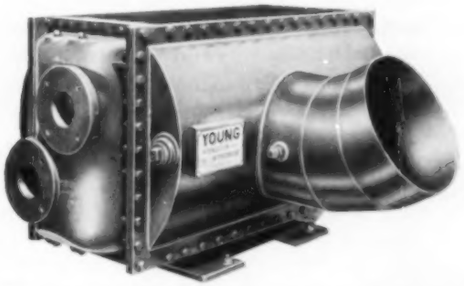
UTILITY SPACE HEATERS—Used to recover waste heat and warm any enclosed space, such as locomotive cabs, buildings housing power plants, warehouses, etc. Also useful in preventing freezing of the radiator.



Here are five HC ® units by Young in use at a natural gas pipeline compressor station. They are used both for the cooling of the compressor engines and the gas itself. Other applications of these horizontal core units find them cooling oil or condensing steam or vapor or performing a combination of these tasks. Horizontal design eliminates effect of cross-winds and recirculation of air, cuts down weather damage. Independent fan mounting minimizes wear from vibration. HC units can be obtained with removable core sections for ease and economy of maintenance and repair.



Locomotive cab and general utility heater for hot water or low pressure steam is simple in design, provides efficient space heating. About fifteen inches in height, the heater can be furnished with mountings shown, or alternate mountings to meet installation requirements. For rugged service, only seamless tubes and high temperature brazing alloys are used.

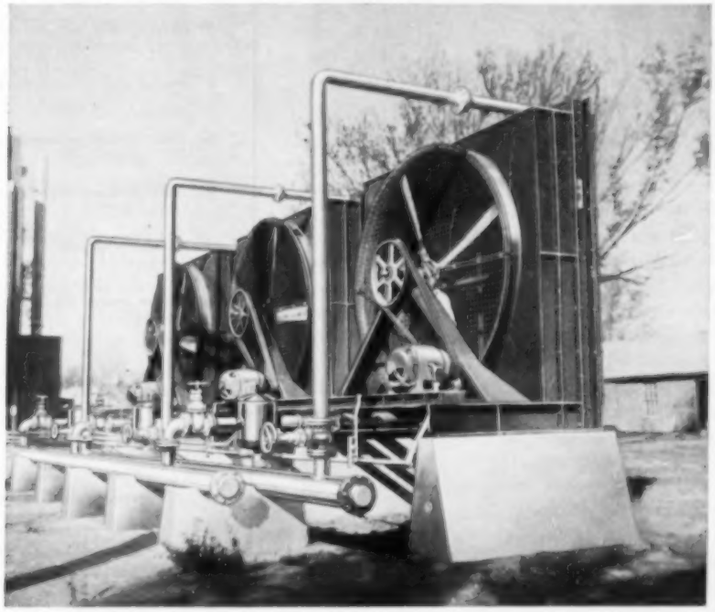


This sea-water type of Young Intercooler-Aftercooler is built to withstand the severe test of salt-water conditions. The round tubes as well as the headers, tanks, and fittings are made of corrosion resistant materials such as admiralty. Cores are scientifically designed and laboratory tested to furnish maximum heat transfer with minimum restriction to air flow.

Young Intercoolers of the fresh-water type shown here have machined cast aluminum side and header plates, copper tubes—either oval or round, and aluminum fins. The high efficiency of the core permits use of compact units. Fabricated steel or cast iron tanks and fittings can be used.

Monofin core provides more extended surface and greater heat transfer contact surface than cores using circular fins of the same thickness and diameter.

Young Evaporative Coolers are completely self-contained units, used to cool either liquid or gas by evaporation of water sprayed over the cooling coils to a lower temperature than could be reached with regular air cooled units. Units can be used to cool engine jacket water, lubricating oil, steam, natural gas or other fluids. Steam, hydrocarbons and other fluids can be condensed by slight variations in basic design. The unit shown here is cooling water for a Corps of Engineers, Bureau of Reclamation, job in North Dakota.



Singly or in batteries like this, Young Jacket Water Coolers set the standard for the industry. These units are cooling the jacket water of a number of stationary generating engines and are connected to common headers. This permits the cooling to be handled either singly by one radiator or as a group contingent upon the engine cooling demands. Whatever the specific cooling or condensing requirement is, Young offers tubes and cores of the right material and design to meet the need. A full line of accessories is also available.

BERGER

HANDRAULIC STARTER

A 'Wakefield' Model 118 Heavy Duty Motor Grader, manufacturer by Construction Machinery Ltd. and powered by a Leyland AU450 engine fitted with a Berger Starter.

THE Berger Handraulic Starter, manufactured by Bryce Berger Limited, is becoming increasingly popular. The accompanying pictures show some of the very varied applications to which it is put. The Starter is hand operated, the power being provided by a combination of pneumatic and hydraulic principles working within a closed circuit. The Starter requires no outside source of energy, and has only three moving parts in the starter unit —two racks and a pinion. Normally it is fitted to the free end of the crankshaft, effecting engagement and starting without noise or shock. The Starter is suitable for practically all types of diesel engine up to 6¼" bore, being particularly useful on engines for contractors' plant, cranes, excavators, agricultural machinery and power units for railway, industrial, mining and marine purposes.

The Starter operates in the following manner: (see the adjacent diagram). The accumulator (J) is filled initially by the manufacturers, with nitrogen compressed to about 2,800 psi and is then sealed. No recharging is required as the nitrogen neither leaks nor is consumed. When nitrogen only is in the accumulator, the piston rests at (K). Hydraulic oil is pumped from the feed tank (N) by the hand pump (O), into the accumulator on the other side of the piston to the nitrogen. The piston is therefore lifted, further compressing the nitrogen until the indicator (P) reads about 4,000 psi. The piston, now being half way up the accumulator (L) is self sealing, completely isolating the nitrogen from the fluid, and, the pressure being equal on both sides, is subject to no strain.

The Starter unit comprises two opposed cylinders each containing a piston-rack (B) which is engaged with a central pinion (A). The pinion is integral with a toothed dog (E) which engages with a corresponding dog (F) on the engine crankshaft. Two spring loaded balls, one on either side of the starter pinion, and running in helical grooves, ensure a forward axial movement (G) of the driving dog, and facilitate smooth engagement with the engine dog. The teeth of the pinion and racks are helical to ensure that sufficient axial thrust is imparted to maintain solid engagement during the starting impulse.

On operating the starting lever (Q) the energy stored in the accumulator is transmitted by the hydraulic fluid to the starter. The starting lever operates a two-stage valve (M), the first stage admitting sufficient pressure to the Starter to engage it gently with the crankshaft. During the second stage, the full pressure is admitted to the heads of the piston-racks and the crankshaft is rotated at high speed with high starting torque. As soon as the engine starts, the dogs automatically disengage and, on release of the starting lever, the racks are returned to their original position by springs, and the fluid is discharged back into the feed tank (N). The equipment is thus available for further starting, by recharging the accumulator with the hand pump. Pumping a full charge takes 2½–3 minutes at a fair rate, although, in many cases, this is not necessary as many engines will start on less than the full charge.

A. Pinion with helical teeth.

B. Piston-racks driving A.

C. Hydraulic fluid inlets.

D. Piston-rack return springs.

E. Driving dog integral with A.

F. Driven dog on crankshaft.

G. Axial thrust for engagement.

H. Starter mounting flange.

J. Hydraulic accumulator.

K. Piston under compressed nitrogen.

L. Piston when lifted by fluid pressure.

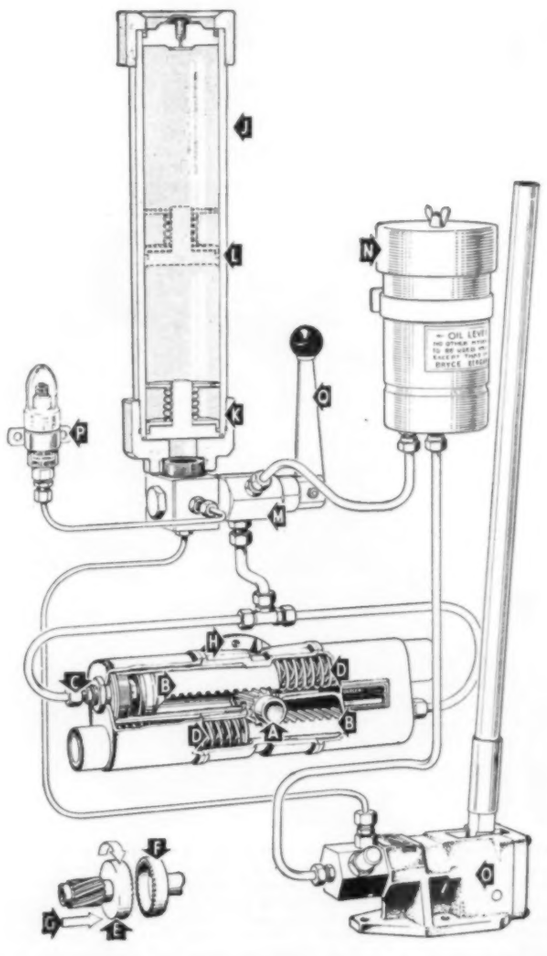
M. Relay starting valve.

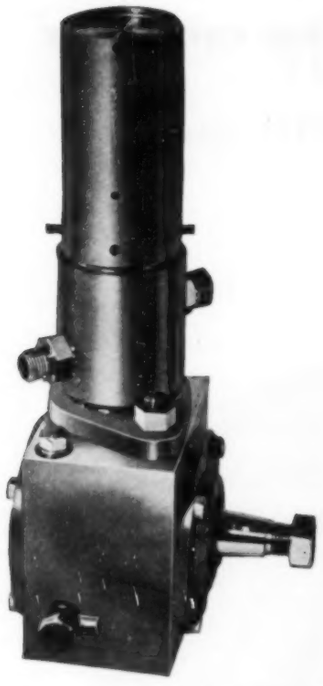
N. Hydraulic fluid feed tank.

O. Hand pump for charging.

P. Plunger pressure indicator.

Q. Starting lever.





The engine driven auto-charging pump, which is available for applications where a number of starts is required during a short period.

Advantages of the Berger Starter are as follows:—

1. It rotates the cranksaft at high speed, an essential for the easy starting of compression ignition engines.
2. It is self contained, needing no outside source of power, such as batteries, air bottles or cartridges.
3. It can be manually charged in 2½–3 minutes and this charge will remain ready until required.
4. It is flame proof.

The plunger pressure indicator, which forms part of the Starter ancilliaries, is suitable (with standard spring ratings) for measuring pressures between 1,500 and 5,000 psi. It has been specially designed to withstand the shocks and vibration usually affecting the Bourdon tube-dial type gauges. Service experience with this unit has shown it to be exceptionally reliable.

The indicator comprises a robust tubular housing containing the cylinder and piston assembly to which the hydraulic pressure is admitted. The piston acts against a spring, the pressure being indicated on a graduated extension of the piston. The unit is strongly made, unaffected by vibration and not liable to damage through rough handling. This Berger indicator is also available as a separate entity; it has many uses apart from with the Starter.

If desired, a small mechanical charging pump, driven by the engine, can be provided, so that, after the initial start, the pump will automatically recharge the accumulator while the engine is running, thus providing an efficient means of enabling a number of starts to be made easily during a short period.

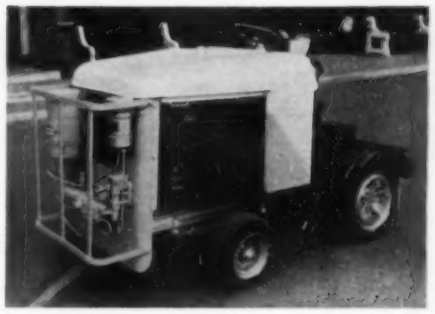
The pump is fully automatic, self-lubricating and may be driven continuously, in either direction, at any speed between 200 and 1,800 rpm. At 1,000 rpm it will charge an accumulator in approximately five minutes. It consists of two main assemblies, the top half containing the pumping unit with delivery valve, the lower half being a cambox, housing an eccentric shaft supported on ball bearings.

The unit is self contained, and is suitable for direct, shaft or belt drive. The maximum torque requirement at commencement of charging is 2 lb/ft or 0.4 horsepower at 1,000 rpm. The drive should have a capacity of ½ hp at 1,000 rpm. The cambox, which is of aluminum alloy, is provided with tapped holes at side and base for attachment to a suitable mounting bracket, or may be flange-mounted with an adaptor. The eccentric shaft, projecting from the cambox, has a tapered extension with woodruff keyway at the end.

The pumping stroke is spring controlled, the eccentric shaft serving to return the pump plunger on the inlet stroke; thus delivery is automatically cut off when the spring load is balanced by the hydraulic load on the plunger. This occurs at approximately 4,000 psi when the accumulator is fully charged. The delivery valve is easily accessible without dismantling the pump. If desired, the pumping element can be mounted direct on the engine and operated by a suitable cam incorporated in the engine design.

It could be that, in exceptionally dusty localities, the entry of dust into the fluid reservoir might interfere with the Starter's reliability; a suitable feed tank has therefore been introduced to meet these requirements. The unit consists of a standard tank with the addition of an oil bath breather unit to the lid; a synthetic rubber sleeve seals the gap between body and lid. The breather unit is detachable for cleaning, and the tank may be replenished without removal of the lid.

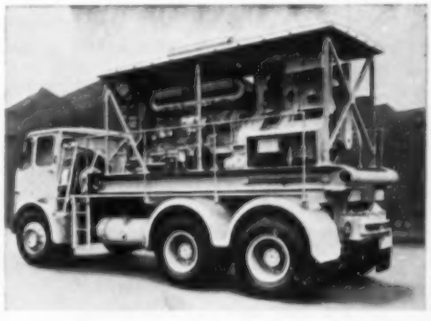
The fire tug "COCKBURN" owned by the British Tanker Co. and operating in Bombay. Merryweather fire pumps are driven by two Rolls Royce oil engines fitted with Berger Starters.



A "Planet" tractor, fitted with a Petter McLaren PD2 aircooled diesel engine used by Butlins Ltd., the British Holiday Camp specialists, for passenger and luggage transportation. The engine is fitted with a Berger Starter.

A British "X" Craft Midget Submarine, H.M.S. STICKLEBACK, powered by Perkins P6 diesel engine which is fitted with a Berger Starter.

A Broom and Wade compressor, fitted with a Berger Starter, in use by the Sutton District Water Co. of England.



A diesel electric mobile winder supplied to the British National Coal Board. The power is provided by an English Electric diesel engine, incorporating a Berger Starter.

START PILOT

DIESEL COLD STARTING EQUIPMENT

THE Start Pilot Corporation is now manufacturing, for over a year, the European designed Start Pilot diesel engine starting device and Start Pilot "multi-start" hermetically sealed aluminum capsules.

The products have found wide application in various U.S. industries, and various branches of the U.S. Government have become users of the Start Pilot device. The "multi-start" aluminum capsules have been tested and have been awarded a Certificate of Acceptance by the New York City Fire Department, which signifies safe storage.

The principal users of the Start Pilot products are the large construction companies, road building companies and mine operators. In addition, several of the important motor fleets, commercial fishing fleets, and several oil companies have adopted the Start Pilot device.

The principal advantages of the Start Pilot are the "multi-start" aluminum capsules, which can be left in the capsule chamber after the initial start until all the fluid has been used up by successive starts.

The users are also greatly pleased with the double action air pump, which allows the engine operator to "follow through" after the initial ignition until the engine idles smoothly.

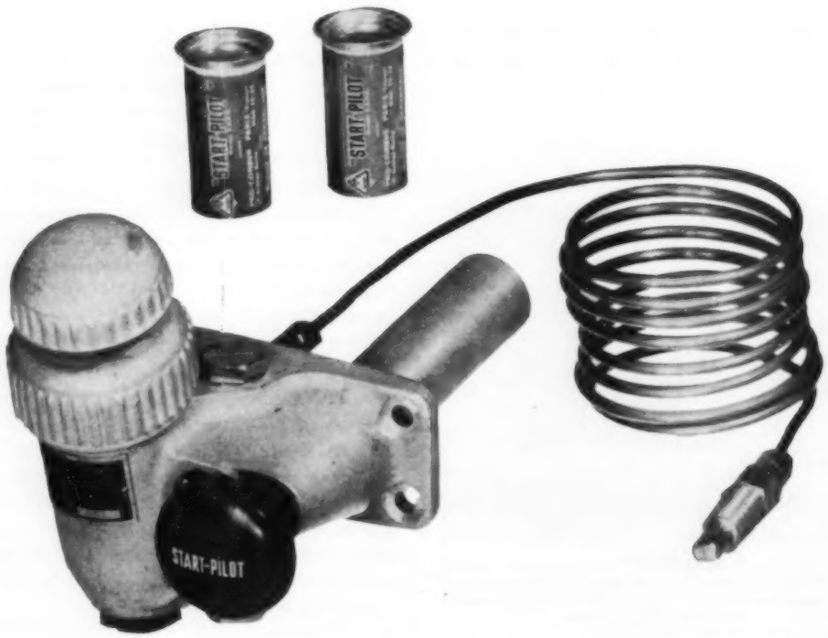
Inasmuch as the major components are of aluminum and brass, and no ferrous components are being used, the Start Pilot device, even when being exposed constantly to all weather conditions, will still continue to function properly.

The severest tests have been made by various U.S. engine companies, Government and privately owned testing laboratories to prove the efficiency of the Start Pilot device and fluid under the coldest weather conditions.

The Start Pilot device and fluid have been accepted as optional equipment by several of the major U.S. engine manufacturers.

A wide network of distributors has been established throughout the United States and they stock both pumps and fluid capsules and service the end users.

This illustrates the plunger which pierces the leak-proof capsule. The entire assembly can, be attached to the instrument panel of a truck, bus or tractor.



The Start Pilot Injection Device showing the nozzle which is screwed into the engine manifold. The Start Pilot leak proof capsule is here illustrated containing enough liquid to give at least five starts.

MARKET PLACE

OF DIESEL ENGINES AND ACCESSORIES

The following sections include the names, addresses, and products of those Diesel Engine and Accessory Manufacturers who have ordered their listings to appear in this MARKET PLACE of the DIESEL ENGINE CATALOG.

Abrasive Cleaning Machines (Wet) —see Cleaning Machines, Abrasive (Wet)

Abrasives

THE CRO-PLATE CO., INC.
747 Windsor Street
Hartford 1, Conn.

VAPOR BLAST MFG. CO.
3005 W. Atkinson Ave.
Milwaukee 16, Wis.

Accessory Drives, Controlled

SCHWITZER CORPORATION
1125 Massachusetts Ave.
Indianapolis 7, Indiana

Acoustical Materials. Also see Felt, Acoustic; Insulating Materials, Sound

KOPPERS COMPANY, INC.
Metal Products Division
200 Scott Street
Baltimore 3, Md.

Absorbers, Vibration—see Vibration Dampers, Absorbers, Isolators

Adapter, Engine Indicator

KIENE DIESEL ACCESSORIES, INC.
10352 Pacific Ave.
Franklin Park, Ill.

Additives, Diesel Fuel

THE PEROLIN COMPANY, INC.
350 Fifth Avenue
New York 1, N. Y.

PETROLEUM SOLVENTS CORPORATION
331 Madison Ave.
New York 17, N.Y.

Additives, Fuel Oil

E. H. KELLOGG & CO., INC.
63-East First St.
Mount Vernon, N.Y.

THE PEROLIN COMPANY, INC.
350 Fifth Avenue
New York 1, N. Y.

PETROLEUM SOLVENTS CORPORATION
331 Madison Ave.
New York 17, N.Y.

Aftercoolers, Air Compressor

INGERSOLL-RAND CO.
11 Broadway
New York 4, N. Y.

ROME-TURNEY RADIATOR CO.
Box 32
Rome, New York

ROSS HEAT EXCHANGER DIV.
of American-Standard
1407 West Ave.
Buffalo 13, N.Y.

UNITED AIRCRAFT PRODUCTS, INC.
1116 Bolander Ave.
Dayton 1, Ohio

YOUNG RADIATOR COMPANY
709 S. Marquette Street
Racine, Wis.

Aftercoolers, Oil

ROSS HEAT EXCHANGER DIV.
of American-Standard
1407 West Ave.
Buffalo 13, N.Y.

UNITED AIRCRAFT PRODUCTS, INC.
1116 Bolander Ave.
Dayton 1, Ohio

YOUNG RADIATOR COMPANY
709 S. Marquette Street
Racine, Wisc.

Aftercoolers, Turbocharger

THE GARRETT CORPORATION,
AiResearch Industrial Div.
9225 Aviation Blvd.
Los Angeles 45, Calif.

ROSS HEAT EXCHANGER DIV.
of American-Standard
1407 West Ave.
Buffalo 13, N.Y.

YOUNG RADIATOR COMPANY
709 S. Marquette Street
Racine, Wis.

Air Blast Equipment—see Sand Blast Equipment

Air Cleaners—see Cleaners, Air; also Air Conditioning & Purifying Equipment

Air Compressors—see Compressors, Air

Air-Cooled Heat Exchangers—see Exchangers, Heat, Air-Cooled

Air Coolers for Turbochargers—see Coolers, Air, for Turbochargers

Air Conditioning & Purifying Equipment

YOUNG RADIATOR COMPANY
709 S. Marquette Street
Racine, Wisc.

Air Conditioning & Purifying Equipment, Railways

THE READY-POWER CO.
11231 Freud Avenue
Detroit 14, Mich.

YOUNG RADIATOR COMPANY
709 S. Marquette Street
Racine, Wisc.

Air Filters—see Filters, Air

Air Starting Motor—see Motors, Air Starting

Air Tools—see Tools, Air

Air Velocity Meters—see Meters, Air Velocity

Air Washers—see Air Conditioning & Purifying Equipment; also, Cleaners, Air

Alarm Gauges—see Gauges, Alarm

Alarm Systems, Pressure & Temperature

CUSTOM BUILT CONTROLS
661 Delaware St.
Denver 4, Colo.

ILLINOIS TESTING LABS., INC.
420 N. La Salle
Chicago 10, Ill.

KYSOR HEATER COMPANY
1100 W. Wright St.
Cadillac, Michigan

ROBERTSHAW-FULTON CONTROLS CO.
Fulton Sylphon Div.
P. O. Box 400
Knoxville 1, Tenn.

TECHNIFLEX MFG. CO., INC.
55 Jersey Ave.
Port Jervis, N. Y.

THE UNION DIESEL ENGINE COMPANY
2121 Diesel Street
Oakland 6, Calif.

Alarms, Electronic

TECHNIFLEX MFG. CO., INC.
55 Jersey Ave.
Port Jervis, N. Y.

Alarms, Liquid Level

THE MERIAM INSTRUMENT CO.
10920 Madison Avenue
Cleveland 2, Ohio

SCULLY SIGNAL COMPANY
174 Green Street
Melrose 76, Mass.

TECHNIFLEX MFG. CO., INC.
55 Jersey Ave.
Port Jervis, N. Y.

Alarms, Low Oil Pressure

KYSOR HEATER COMPANY
1100 W. Wright St.
Cadillac, Michigan

TECHNIFLEX MFG. CO., INC.
55 Jersey Ave.
Port Jervis, N. Y.

Alternators

ELECTRO-MOTIVE DIVISION
General Motors
La Grange, Ill.

Ammeters

THE ELECTRIC AUTO-LITE CO.
Champlain
Toledo 1, Ohio

Ammeters, Tong Test Type

COLUMBIA ELECTRIC MFG. CO.
4557 Hamilton Ave.
Cleveland 14, Ohio

Anti-Rust Compounds—see Compounds, Rust Resistant

Arresters, Flame, for Stationary Storage Tanks

THE TOKHEIM COMPANY
1115 "C" Ave. N.W.
Cedar Rapids, Iowa

Arresters, Spark, Exhaust

BURGESS-MANNING COMPANY
749 E. Park Ave.
Libertyville, Ill.

HARCO MANUFACTURING CO.
2041 S.W. 58th
Portland 1, Ore.

KITTELL MUFFLER & ENGINEERING, INC.
915 S. Santa Fe
Los Angeles 21, Calif.

THE MAXIM SILENCER COMPANY
85 Homestead Ave.
Hartford 1, Conn.

Asbestos & Asbestos Materials

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

VICTOR MANUFACTURING & GASKET CO.
5750 Roosevelt Rd.
Chicago 50, Ill.

Automatic Controls—see Controls, Automatic; also see Regulators

Automatic Generator Sets—see Generator Sets, Automatic

Automatic Power Plants—see Power Plants, Automatically Controlled

Automatic Starting Controls—see Controls, Automatic, Starting

Automatic Transfer Switches—see Switches, Transfer, Automatic

Automotive Diesel Fuel—see Fuels, Diesel, Automotive

Automotive Lubricating Oil—see Oil, Lubricating, Automotive

Auxiliary Engine Generator Sets—see Engine Generator Sets, Auxiliary; also Engine Generator Sets, Marine

Auxiliary Engines—see Engines, Auxiliary

Auxiliary Transmissions—see Transmissions, Auxiliary

Auxiliary Units, Marine

D. NAPIER AND SON LTD.
Acton Vale
London, England

NATIONAL METAL & STEEL CORP., Diesel Div.
1251 New Dock Street
Terminal Island, Calif.

NORDBERG MANUFACTURING COMPANY
3073 South Chase Avenue
Milwaukee 1, Wis.

F. PERKINS LIMITED
Peterborough, England

R. H. SHEPPARD CO., INC.
Hanover, Pa.

Axles, Driving & Steering

CLARK EQUIPMENT COMPANY
P. O. Box 31
Buchanan, Michigan

Axles, Trailer

CLARK EQUIPMENT COMPANY
P. O. Box 31
Buchanan, Michigan

Balancing Machines, Static & Dynamic

GISHOLT MACHINE COMPANY
1251 E. Washington Ave.
Madison 10, Wis.

TAYLOR DYNAMOMETER AND MACHINE COMPANY
6411 River Parkway
Milwaukee 13, Wis.

STEWART-WARNER CORPORATION
1826 Diversey Parkway
Chicago 14, Illinois

Balancing School

GISHOLT MACHINE COMPANY
1251 E. Washington Ave.
Madison 10, Wis.

Balancing Tools

STEWART-WARNER CORPORATION
1826 Diversey Parkway
Chicago 14, Illinois

Ball Joints—see Joints, Flexible, for Air, Steam, Water, Oil, etc.

Bars, Bronze

BEARIUM METALS CORP.
Mill and Commercial Sts.
Rochester 14, N. Y.

Bases, Engine, Welded

EXLINE ENGINE WORKS
Box 446
Salina, Kansas

Bases & Frames, Machine (Welded Steel, etc.)

ALCO PRODUCTS, INC.
P. O. Box 1065
Schenectady 1, N. Y.

THE DAYTON FABRICATED STEEL COMPANY
1300 E. Monument Ave.
Dayton 3, Ohio

Batteries, Diesel Locomotive

NICKEL CADMIUM BATTERY CORPORATION
Pleasant Street
Easthampton, Mass.

Batteries, Diesel Starting, Truck, Bus, Tractor, etc.

THE ELECTRIC AUTO-LITE CO.
Champlain
Toledo 1, Ohio

WILLARD STORAGE BATTERY COMPANY
246 E. 131st St.
Cleveland 1, Ohio

Batteries, Storage

NICKEL CADMIUM BATTERY CORPORATION
Pleasant Street
Easthampton, Mass.

SURRETTE STORAGE BATTERY COMPANY, INC.
Jefferson Avenue
Salem, Mass.

WILLARD STORAGE BATTERY COMPANY
246 E. 131st St.
Cleveland 1, Ohio

Batteries, Storage, for Industrial Purposes

SURRETTE STORAGE BATTERY COMPANY, INC.
Jefferson Avenue
Salem, Mass.

WILLARD STORAGE BATTERY COMPANY
246 E. 131st St.
Cleveland 1, Ohio

Batteries, Storage, Lead-Acid

SURRETTE STORAGE BATTERY COMPANY, INC.
Jefferson Avenue
Salem, Mass.

Batteries, Storage, Marine

NICKEL CADMIUM BATTERY CORPORATION
Pleasant Street
Easthampton, Mass.

SURRETTE STORAGE BATTERY COMPANY, INC.
Jefferson Avenue
Salem, Mass.

WILLARD STORAGE BATTERY COMPANY
246 E. 131st St.
Cleveland 1, Ohio

Batteries, Storage, Nickel Cadmium

NICKEL CADMIUM BATTERY CORPORATION
Pleasant Street
Easthampton, Mass.

Batteries, Storage, Railroad

SURRETTE STORAGE BATTERY COMPANY, INC.
Jefferson Avenue
Salem, Mass.

Batteries, Storage, Starting

SURRETTE STORAGE BATTERY COMPANY, INC.
Jefferson Avenue
Salem, Mass.

Batteries, Storage, Truck, Tractor, Bus, etc.

SURRETTE STORAGE BATTERY COMPANY, INC.
Jefferson Avenue
Salem, Mass.

WILLARD STORAGE BATTERY COMPANY
246 E. 131st St.
Cleveland 1, Ohio

Battery Chargers & Testers—see Chargers, Storage Battery

Battery Charging Regulators—see Regulators, Battery Charging

Battery, Lighting System, Emergency

NICKEL CADMIUM BATTERY CORPORATION
Pleasant Street
Easthampton, Mass.

SURRETTE STORAGE BATTERY COMPANY, INC.
Jefferson Avenue
Salem, Mass.

Bearing Oil Seals—see Seals, Oil, Grease or Dust

Bearings, Alloy

THE BUNTING BRASS & BRONZE COMPANY
715 Spencer Street
Toledo 1, Ohio

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

Bearings, Aluminum

ALUMINUM COMPANY OF AMERICA
Dept. 1100 Alcoa Bldg.
Pittsburgh 19, Pa.

AMERICAN BEARING CORP.
429 S. Harding
Indianapolis 7, Ind.

BOHN ALUMINUM & BRASS CORPORATION
1400 Lafayette Bldg.
Detroit 26, Mich.

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

EXLINE ENGINE WORKS
Box 446
Salina, Kan.

FEDERAL-MOGUL DIVISION
Federal-Mogul-Bower Bearings Incorporated
11031 Shoemaker Ave.
Detroit 13, Mich.

JOHNSON BRONZE COMPANY
500 S. Mill St.
New Castle, Pa.

PIONEER MOTOR BEARING CO.
116 Beacon St.
South San Francisco, Cal.

Bearings, Aluminum, Steel Back

JOHNSON BRONZE COMPANY
500 S. Mill St.
New Castle, Pa.

Bearings, Anti-Friction

CHAIN BELT COMPANY
4701 W. Greenfield Ave.
Milwaukee 1, Wis.

Bearings, Babbitted

AMERICAN BEARING CORP.
429 S. Harding
Indianapolis 7, Ind.

THE BUNTING BRASS & BRONZE COMPANY
715 Spencer Street
Toledo 1, Ohio

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

DETROIT ALUMINUM & BRASS CORPORATION
3975 Christopher Ave.
Detroit 11, Mich.

DURA-BOND ENGINE PARTS CO.
715 Loma Verde Ave.
Palo Alto, Calif.

FEDERAL-MOGUL DIVISION
Federal-Mogul-Bower Bearings Incorporated
11031 Shoemaker Ave.
Detroit 13, Mich.

JOHNSON BRONZE COMPANY
500 S. Mill St.
New Castle, Pa.

PIONEER MOTOR BEARING CO.
116 Beacon St.
South San Francisco, Cal.

Bearings, Bronze

AMERICAN BEARING CORP.
429 S. Harding
Indianapolis 7, Ind.

BEARIUM METALS CORPORATION
Mill and Commercial Sts.
Rochester 14, N.Y.

THE BUNTING BRASS & BRONZE COMPANY
715 Spencer Street
Toledo 1, Ohio

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

DETROIT ALUMINUM & BRASS CORPORATION
3975 Christopher Ave.
Detroit 11, Mich.

FEDERAL-MOGUL DIVISION
FEDERAL-MOGUL-BOWER BEARINGS, INC.
11031 Shoemaker Ave.
Detroit 13, Mich.

JOHNSON BRONZE COMPANY
500 S. Mill St.
New Castle, Pa.

PIONEER MOTOR BEARING CO.
116 Beacon St.
South San Francisco, Cal.

Bearings, Cam Follower

THE BUNTING BRASS & BRONZE COMPANY
715 Spencer Street
Toledo 1, Ohio

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

Bearings, Cast Iron Black, Kolened, Babbitted

NICKLES MACHINE CORPORATION
600 South First Street
Ponca City, Okla.

Bearings, Graphited Bronze

THE BUNTING BRASS & BRONZE COMPANY
715 Spencer Street
Toledo 1, Ohio

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

FEDERAL-MOGUL DIVISION
Federal-Mogul-Bower Bearings Incorporated
11031 Shoemaker Ave.
Detroit 13, Mich.

JOHNSON BRONZE COMPANY
500 S. Mill St.
New Castle, Pa.

Bearings, Lead-Bronze

BEARIUM METALS CORPORATION
Mill and Commercial Sts.
Rochester 14, N.Y.

Bearings, Lead Lined

AMERICAN BEARING CORP.
429 S. Harding
Indianapolis 7, Ind.

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

FEDERAL-MOGUL DIVISION
Federal-Mogul-Bower Bearings Incorporated
11031 Shoemaker Ave.
Detroit 13, Mich.

Bearings, Oil-less

THE BUNTING BRASS & BRONZE COMPANY
715 Spencer Street
Toledo 1, Ohio

JOHNSON BRONZE COMPANY
500 S. Mill St.
New Castle, Pa.

Bearings, Pillow Block, Babbitted Type

CHAIN BELT COMPANY
4701 W. Greenfield Ave.
Milwaukee 1, Wis.

CLEVELAND GRAPHITE BRONZE COMPANY
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

Bearings, Pillow Block, Roller Type

CHAIN BELT COMPANY
4701 W. Greenfield Ave.
Milwaukee 1, Wis.

Bearings, Piston Pin

AMERICAN BEARING CORP.
429 S. Harding
Indianapolis 7, Ind.

THE BUNTING BRASS & BRONZE COMPANY
715 Spencer Street
Toledo 1, Ohio

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

JOHNSON BRONZE COMPANY
500 S. Mill St.
New Castle, Pa.

Bearings, Plated

AMERICAN BEARING CORP.
429 S. Harding
Indianapolis 7, Ind.

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

Bearings, Propeller Shaft, Rubber

LUCIAN Q. MOFFITT INC.
504 Evans Building
Akron 8, Ohio

Bearings, Pump, Rubber

LUCIAN Q. MOFFITT INC.
504 Evans Building
Akron 8, Ohio

Bearings, Rebabbitted

BRODIE SYSTEM
115 Clifton Place
Brooklyn 38, N.Y.

EXLINE ENGINE WORKS
Box 446
Salina, Kansas

NICKLES MACHINE CORPORATION
600 South First Street
Ponca City, Okla.

PIONEER MOTOR BEARING CO.
116 Beacon St.
South San Francisco, Cal.

Bearings, Roller

CHAIN BELT COMPANY
4701 W. Greenfield Ave.
Milwaukee 1, Wis.

Bearings, Self-Lubricating

BEARIUM METALS CORPORATION
Mill and Commercial Sts.
Rochester 14, N.Y.

THE BUNTING BRASS & BRONZE COMPANY
715 Spencer Street
Toledo 1, Ohio

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

JOHNSON BRONZE COMPANY
500 S. Mill St.
New Castle, Pa.

Bearings, Sleeve, Copper-Lead Lined

ALLISON DIVISION
General Motors Corporation
P. O. Box 894
Indianapolis 6, Ind.

AMERICAN BEARING CORP.
429 S. Harding
Indianapolis 7, Ind.

DETROIT ALUMINUM & BRASS CORPORATION
3975 Christopher Ave.
Detroit 11, Mich.

FEDERAL-MOGUL DIVISION
Federal-Mogul-Bower Bearings Incorporated
11031 Shoemaker Ave.
Detroit 13, Mich.

JOHNSON BRONZE COMPANY
500 S. Mill St.
New Castle, Pa.

Bearings, Special Alloy

AMERICAN BEARING CORP.
429 S. Harding
Indianapolis 7, Ind.

THE BUNTING BRASS & BRONZE COMPANY
715 Spencer Street
Toledo 1, Ohio

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

DETROIT ALUMINUM & BRASS CORPORATION
3975 Christopher Ave.
Detroit 11, Mich.

Bearings, Steel Backed, Aluminum Lined

BOHN ALUMINUM & BRASS CORPORATION
1400 Lafayette Bldg.
Detroit 26, Mich.

Bearings, Steel Backed, Babbitt Lined

AMERICAN BEARING CORP.
429 S. Harding
Indianapolis 7, Ind.

BOHN ALUMINUM & BRASS CORPORATION
1400 Lafayette Bldg.
Detroit 26, Mich.

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

DETROIT ALUMINUM & BRASS CORPORATION
3975 Christopher Ave.
Detroit 11, Mich.

DURA-BOND ENGINE PARTS CO.
715 Loma Verde Ave.
Palo Alto, Calif.

FEDERAL-MOGUL DIVISION
Federal-Mogul-Bower Bearings Incorporated
11031 Shoemaker Ave.
Detroit 13, Mich.

JOHNSON BRONZE COMPANY
500 S. Mill St.
New Castle, Pa.

PIONEER MOTOR BEARING CO.
116 Beacon St.
South San Francisco, Cal.

Bearings, Steel Backed, Bronze Lined

ALLISON DIVISION
General Motors Corporation
P. O. Box 894
Indianapolis 6, Ind.

AMERICAN BEARING CORP.
429 S. Harding
Indianapolis 7, Ind.

BOHN ALUMINUM & BRASS CORPORATION
1400 Lafayette Bldg.
Detroit 26, Mich.

If short runs and long deliveries are a headache, let us quote on your heavy wall engine bearing requirements.
We welcome any quantity—large or small—and are prepared to meet your delivery schedules.
For service work ask about our industrial re-babbitting facilities.

PIONEER MOTOR BEARING CO.

Now in our new plant . . .

116 BEACON ST., SOUTH SAN FRANCISCO, CALIF.
PHONE . . . . PLAZA 5-2607

MARKET PLACE — CONTINUED

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

DETROIT ALUMINUM & BRASS CORPORATION
3975 Christopher Ave.
Detroit 11, Mich.

FEDERAL-MOGUL DIVISION
Federal-Mogul-Bower Bearings Incorporated
11031 Shoemaker Ave.
Detroit 13, Mich.

JOHNSON BRONZE COMPANY
500 S. Mill St.
New Castle, Pa.

Bearings, Steel Backed, Copper-Lead Lined

ALLISON DIVISION
General Motors Corporation
P. O. Box 894
Indianapolis 6, Ind.

AMERICAN BEARING CORP.
429 S. Harding
Indianapolis 7, Ind.

BOHN ALUMINUM & BRASS CORPORATION
1400 Lafayette Bldg.
Detroit 26, Mich.

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

DETROIT ALUMINUM & BRASS CORPORATION
3975 Christopher Ave.
Detroit 11, Mich.

FEDERAL-MOGUL DIVISION
Federal-Mogul-Bower Bearings Incorporated
11031 Shoemaker Ave.
Detroit 13, Mich.

JOHNSON BRONZE COMPANY
500 S. Mill St.
New Castle, Pa.

Bearings, Tri-Metal

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

DETROIT ALUMINUM & BRASS CORPORATION
3975 Christopher Ave.
Detroit 11, Mich.

Bearings, Water Lubricated, Rubber

LUCIAN Q. MOFFITT, INC.
504 Evans Building
Akron 8, Ohio

Bearings, Wrist Pin

BOHN ALUMINUM & BRASS CORPORATION
1400 Lafayette Bldg.
Detroit 26, Mich.

THE BUNTING BRASS & BRONZE COMPANY
715 Spencer Street
Toledo 1, Ohio

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

FEDERAL-MOGUL DIVISION
FEDERAL-MOGUL-BOWER BEARINGS, INC.
11031 Shoemaker Ave.
Detroit 13, Mich.

Bearium Metal

BEARIUM METALS CORPORATION
Mill and Commercial Sts.
Rochester 14, N.Y.

Beds, Machine—see Bases & Frames, Machine (Welded Steel, etc.)

Bellows, Metallic

THE BRISTOL COMPANY
P. O. Box 1790 DEC
Waterbury 20, Conn.

FLEXONICS CORPORATION
1325 S. Third Ave.
Maywood, Illinois

Bellows, Stainless Steel

ZALLEA BROTHERS
830 Locust St.
Wilmington 99, Del.

Blanks, Gear, Forged

ALCO PRODUCTS, INC.
P. O. Box 1065
Schenectady 1, N.Y.

ENDICOTT FORGING & MFG. CO., INC.
1911 North St.
Endicott, N.Y.

ERIE FORGE & STEEL CORP.
Erie, Pa.

THE PARK DROP FORGE COMPANY
777 E. 79th St.
Cleveland 3, Ohio

Blast Cleaning Equipment, Wet Abrasive

THE CRO-PLATE CO., INC.
747 Windsor Street
Hartford 1, Conn.

VAPOR BLAST MFG. CO.
3005 W. Atkinson Ave.
Milwaukee 16, Wis.

Blocks, Cylinder, Welded, Diesel

BRODIE SYSTEM
115 Clifton Place
Brooklyn 38, N.Y.

EXLINE ENGINE WORKS
Box 446
Salina, Kansas

GUTH COMPANY
400-412 North Chestnut
McPherson, Kansas

RALPH STARK, INC.
43-12 33rd Street
Long Island City 1, N.Y.

Block & Head Repair, Diesel

ALCO PRODUCTS, INC.
P. O. Box 1065
Schenectady 1, N.Y.

RALPH STARK, INC.
43-12 33rd Street
Long Island City 1, N.Y.

Blocks, Engine, Welded

RALPH STARK, INC.
43-12 33rd Street
Long Island City 1, N.Y.

Blocks, Welded

Blower Drives—see Drives, Blower

Blowers, Centrifugal

BROWN BOVERI CORPORATION
19 Rector St.
New York 6, N.Y.

DR. ALFRED J. BUCHI
Engineering Office
Winterthur, Switzerland

DE LAVAL STEAM TURBINE CO.
Trenton 2, New Jersey

ELLIOTT COMPANY
Jeannette, Pa.

ROOTS-CONNERSVILLE BLOWER
900 West Mount St.
Connersville, Ind.

Blowers, Rotary Pressure

MIEHLE-DEXTER SUPERCHARGER
100 Fourth Street
Racine, Wis.

ROOTS-CONNERSVILLE BLOWER
900 West Mount St.
Connersville, Ind.

WADE ENGINEERING LTD.
Crowhurst Road
Brighton 6, Sussex, England

Blowers, Scavenging, for Oil & Gas Engines

DR. ALFRED J. BUCHI
Engineering Office
Winterthur, Switzerland

SIR GEORGE GODFREY & PARTNERS (INDUSTRIAL) LTD.
Hampton Road West
Hanworth, Middx., England

MIEHLE-DEXTER SUPERCHARGER
100 Fourth Street
Racine, Wis.

ROOTS-CONNERSVILLE BLOWER
900 West Mount St.
Connersville, Ind.

WADE ENGINEERING LTD.
Crowhurst Road
Brighton 6, Sussex, England

Blowers, Scavenging & Supercharging

DR. ALFRED J. BUCHI
Engineering Office
Winterthur, Switzerland

THE GARRETT CORPORATION
AiResearch Industrial Div.
9225 Aviation Blvd.
Los Angeles 45, Calif.

SIR GEORGE GODFREY & PARTNERS (INDUSTRIAL) LTD.
Hampton Road West
Hanworth, Middx., England

MIEHLE-DEXTER SUPERCHARGER
100 Fourth Street
Racine, Wis.

ROOTS-CONNERSVILLE BLOWER
900 West Mount St.
Connersville, Ind.

SCHWITZER CORPORATION
1125 Massachusetts
Indianapolis 7, Ind.

WADE ENGINEERING LTD.
Crowhurst Road
Brighton 6, Sussex, England

Blowers & Superchargers, Scavenging

ELLIOTT COMPANY
Jeannette, Penna.

SIR GEORGE GODFREY & PARTNERS (INDUSTRIAL) LTD.
Hampton Road West
Hanworth, Middx., England

MIEHLE-DEXTER SUPERCHARGER
100 Fourth Street
Racine, Wis.

ROOTS-CONNERSVILLE BLOWER
900 West Mount St.
Connersville, Indiana

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Engineering Office
Winterthur, Switzerland

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Erie, Pa.

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ERIE BOLT & NUT CO.
1325 Liberty
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Detroit 13, Mich.

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Rochester 14, N.Y.

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Division of Clevite Corporation
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Cleveland 10, Ohio

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Division of Clevite Corporation
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Cleveland 10, Ohio

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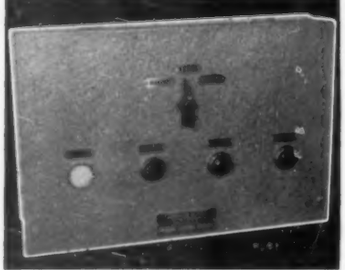

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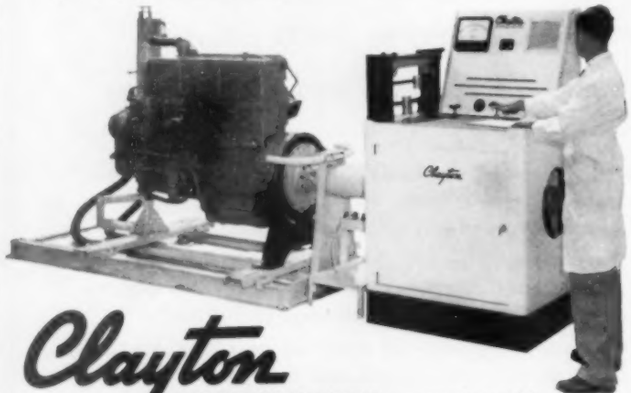

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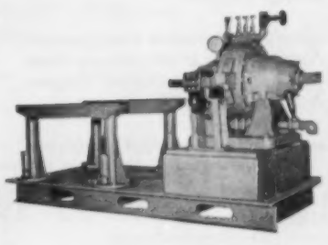

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1600 Oakland Ave.
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Crystal Lake, Illinois

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Springfield, Ohio

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Engines, Diesel, Transportation

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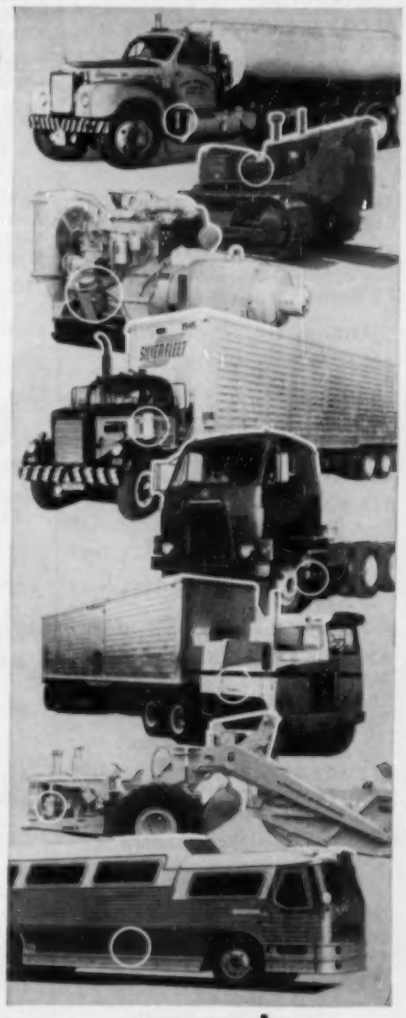

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Libertyville, Ill.

STRATOFLEX, INC.
P. O. Box 10398
Fort Worth, Texas

Fittings, Hose—see Couplings, Hose

Fittings, Inverted, SAE, Steel

ANCHOR COUPLING CO., INC.
342 N. Fourth St.
Libertyville, Ill.

Fittings, Lubrication

STEWART-WARNER CORPORATION
1826 Diversey Parkway
Chicago 14, Illinois

Fittings, Pipe, Compression

DRESSER MANUFACTURING DIVISION
41 Fisher Avenue
Bradford, Pa.

Fittings, Pipe, Welding

ALCO PRODUCTS, INC.
P. O. Box 1065
Schenectady 1, N.Y.

DRESSER MANUFACTURING DIVISION
41 Fisher Avenue
Bradford, Pa.

TUBE TURNS—A DIVISION OF NATIONAL CYLINDER GAS CO.
224 E. Broadway
Louisville, Ky.

Fittings, Seamless Welding

LADISH CO.
5481 S. Packard Ave.
Cudahy, Wisconsin

TUBE TURNS—A DIVISION OF NATIONAL CYLINDER GAS. CO.
224 E. Broadway
Louisville, Ky.

Fittings, Steel

THE WEATHERHEAD COMPANY
128 W. Washington Blvd.
Ft. Wayne, Indiana

Fittings, Tube

ANCHOR COUPLING CO., INC.
342 N. Fourth St.
Libertyville, Ill.

SCOVILL MANUFACTURING COMPANY
99 Mill Street
Waterbury 20, Conn.

THE WEATHERHEAD COMPANY
128 W. Washington Blvd.
Ft. Wayne, Indiana

Fittings, Tubing, Flexible

THE AMERICAN BRASS COMPANY
American Metal Hose Branch
698 South Main Street
Waterbury 20, Conn.

THE WEATHERHEAD COMPANY
128 W. Washington Blvd.
Ft. Wayne, Indiana

Fittings, Welding

TUBE TURNS—A DIVISION OF NATIONAL CYLINDER GAS. CO.
224 E. Broadway
Louisville, Ky.

Flame Arresters—see Arresters, Flame

Flanges, Drop Forged

ALCO PRODUCTS, INC.
P. O. Box 1065
Schenectady 1, N.Y.

LADISH CO.
5481 S. Packard Ave.
Cudahy, Wisconsin

ENDICOTT FORGING & MFG. CO. INC.
1911 North St.
Endicott, N.Y.

Flanges, Welding, Ferrous & Non-Ferrous Materials

LADISH CO.
5481 S. Packard Ave.
Cudahy, Wisconsin

TUBE TURNS—A DIVISION OF NATIONAL CYLINDER GAS CO.
224 E. Broadway
Louisville, Ky.

Flexible Couplings—see Couplings, Flexible

Flexible Exhaust Connection—see Connection, Exhaust, Flexible Metal

Flexible Hose Lines—see Lines, Hose, Flexible

Flexible Joints—see Joints, Flexible

Flexible Metal Hose—see Hose, Flexible Metal

Flexible Metal Lines—see Lines, Flexible Metal

Flexible Shaft Couplings
Also see Couplings, Flexible

CHAIN BELT COMPANY
4701 W. Greenfield Ave.
Milwaukee 1, Wis.

KOPPERS COMPANY, INC.
Metal Products Division
200 Scott Street
Baltimore 3, Md.

Flexible Shafts & Equipment

Flexible Tubing, Non-Metallic—see Tubing, Flexible, Non-Metallic

Flow Alarm Switches—see Switches, Flow Alarm

Fluid Drives—see Drives, Fluid

Fluid Motors—see Motors, Hydraulic

Forgings, Aluminum

ALUMINUM COMPANY OF AMERICA
Dept. 1100 Alcoa Building
Pittsburgh 19, Pa.

SCOVILL MANUFACTURING COMPANY
99 Mill Street
Waterbury 20, Conn.

WYMAN-GORDON COMPANY
105 Madison St.
Worcester 1, Mass.

Forgings, Aluminum Alloy

ALUMINUM COMPANY OF AMERICA
Dept. 1100 Alcoa Building
Pittsburgh 19, Pa.

SCOVILL MANUFACTURING COMPANY
99 Mill Street
Waterbury 20, Conn.

Forgings, Crankshaft, Camshaft, Connecting Rod

ELLWOOD CITY FORGE COMPANY
Tenth Street
Ellwood City, Pa.

ERIE FORGE & STEEL CORP.
Erie, Pa.

LADISH CO.
5481 S. Packard Ave.
Cudahy, Wisconsin

THE PARK DROP FORGE COMPANY
777 E. 79th St.
Cleveland 3, Ohio

WYMAN-GORDON COMPANY
105 Madison St.
Worcester 1, Mass.

Forgings, Die

THE PARK DROP FORGE COMPANY
777 E. 79th St.
Cleveland 3, Ohio

SCOVILL MANUFACTURING COMPANY
99 Mill Street
Waterbury 20, Conn.

WYMAN-GORDON COMPANY
105 Madison St.
Worcester 1, Mass.

Forgings, Drop

CLARK EQUIPMENT COMPANY
P. O. Box 31
Buchanan, Michigan

ENDICOTT FORGING & MFG. CO. INC.
1911 North St.
Endicott, N.Y.

SCOVILL MANUFACTURING COMPANY
99 Mill Street
Waterbury 20, Conn.

Forgings, Hammered & Pressed

ALCO PRODUCTS, INC.
P. O. Box 1065
Schenectady 1, N.Y.

SCOVILL MANUFACTURING COMPANY
99 Mill Street
Waterbury 20, Conn.

WYMAN-GORDON COMPANY
105 Madison St.
Worcester 1, Mass.

Forgings, Press

ELLWOOD CITY FORGE COMPANY
Tenth Street
Ellwood City, Pa.

SCOVILL MANUFACTURING COMPANY
99 Mill Street
Waterbury 20, Conn.

Forgings, Stainless Steel

ENDICOTT FORGING & MFG. CO. INC.
1911 North St.
Endicott, N.Y.

Forgings, Steel

ELLWOOD CITY FORGE COMPANY
Tenth Street
Ellwood City, Pa.

Forgings, Steel, Carbon & Alloy

ALCO PRODUCTS, INC.
P. O. Box 1065
Schenectady 1, N.Y.

ELLWOOD CITY FORGE COMPANY
Tenth Street
Ellwood City, Pa.

ENDICOTT FORGING & MFG. CO. INC.
1911 North St.
Endicott, N.Y.

ERIE FORGE & STEEL CORP.
Erie, Pa.

WYMAN-GORDON COMPANY
105 Madison St.
Worcester 1, Mass.

Forgings, Upset

ALCO PRODUCTS, INC.
P. O. Box 1065
Schenectady 1, N.Y.

ENDICOTT FORGING & MFG. CO. INC.
1911 North St.
Endicott, N.Y.

Fuel Injection Equipment for Diesels—see Injectors

Fuel Injection Nozzle & Needle Servicing Equipment

AMERICAN BOSCH DIVISION
American Bosch Arma Corporation
3664 Main Street
Springfield 7, Mass.

Fuel Injection Systems

ADECO PRODUCTS, INC.
5435 No. Wolcott Ave.
Chicago 40, Illinois

AMERICAN BOSCH DIVISION
American Bosch Arma Corporation
3664 Main Street
Springfield 7, Mass.

ROBERT BOSCH CORPORATION
268 Fourth Avenue
New York 10, N.Y.

C.A.V. FUEL INJECTION EQUIPMENT
Division of Lucas Electrical Services, Inc.
14820 Detroit Avenue
Cleveland 7, Ohio

HARTFORD MACHINE SCREW CO.
Box 1440
Hartford 2, Conn.

MICRO PRECISION DIVN. of Micromatic Hone Corp.
2205 Lee St.
Evanston, Ill.

SCINTILLA DIVISION
Bendix Aviation Corp.
Delaware Avenue
Sidney, N. Y.

Fuel Injection Systems, Repair & Service

ADECO PRODUCTS, INC.
5435 No. Wolcott Ave.
Chicago 40, Illinois

ROBERT BOSCH CORPORATION
268 Fourth Avenue
New York 10, N.Y.

INTERSTATE DIESEL SERVICE INC.
2093 E. 19th St.
Cleveland 15, Ohio

KENT-MOORE ORG., INC.
28635 Mound Road
Warren, Michigan

Fuel Oil Additives—see Additives, Fuel Oil

Fuel Oil, Diesel—see Oil, Diesel Fuel

Fuel Oil Heaters—see Heaters, Fuel Oil

Fuel Oil Purifiers—see Purifiers, Fuel Oil

Fuels, Diesel, Automotive

ASHLAND OIL & REFINING CO.
1409 Winchester Ave.
Ashland, Ky.

SINCLAIR REFINING CO.
600 Fifth Ave.
New York 20, N.Y.

Gas Engines—see Engines, Gas

Gasket Compound—see Compounds, Gasket

Gasket Cutters, Circular—see Cutters, Gasket, Circular

Gaskets, All Metal Laminated

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

Gaskets, Asbestos

THE ALLPAX COMPANY, INC.
160 Jefferson Avenue
Mamaroneck, New York

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

F. D. FARNAM CO.
4940 W. Flournoy St.
Chicago 44, Ill.

VICTOR MANUFACTURING & GASKET CO.
5750 Roosevelt Rd.
Chicago 50, Ill.

WISCONSIN GASKET & MFG. CO.
Granville, Wis.

Gaskets, Asbestos, Fibrous, Metallic, Oil & Water

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

THE FITZGERALD MFG. CO.
Torrington, Conn.

UNITED PACKING & GASKET ENGINEERING CORPORATION
5111 W. Ogden Ave.
Cicero 50, Illinois

VICTOR MANUFACTURING & GASKET CO.
5750 Roosevelt Rd.
Chicago 50, Ill.

WISCONSIN GASKET & MFG. CO.
Granville, Wis.

Gaskets, Asbestos, Metal Spiral Wound

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

Gaskets, Boiler

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

WISCONSIN GASKET & MFG. CO.
Granville, Wis.

Gaskets, Brass, Bronze, Copper, etc.

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

Gaskets, Compressed Asbestos with Rubber & Neoprene Binder

THE ALLPAX COMPANY, INC.
160 Jefferson Avenue
Mamaroneck, New York

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

F. D. FARNAM CO.
4940 W. Flournoy St.
Chicago 44, Ill.

UNITED PACKING & GASKET ENGINEERING CORPORATION
5111 W. Ogden Ave.
Cicero 50, Illinois

VICTOR MANUFACTURING & GASKET CO.
5750 Roosevelt Rd.
Chicago 50, Ill.

WISCONSIN GASKET & MFG. CO.
Granville, Wis.

Gaskets, Cork

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

F. D. FARNAM CO.
4940 W. Flournoy St.
Chicago 44, Ill.

THE FITZGERALD MFG. CO.
Torrington, Conn.

UNITED PACKING & GASKET ENGINEERING CORPORATION
5111 W. Ogden Ave.
Cicero 50, Illinois

WISCONSIN GASKET & MFG. CO.
Granville, Wis.

Gaskets, Cylinder Head, All Metal Laminated, Aluminum, Copper, Steel

THE FITZGERALD MFG. CO.
Torrington, Conn.

VICTOR MANUFACTURING & GASKET CO.
5750 Roosevelt Rd.
Chicago 50, Ill.

Gaskets, Felt

AMERICAN FELT COMPANY
Glenville, Conn.

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

F. D. FARNAM CO.
4940 W. Flournoy St.
Chicago 44, Ill.

WISCONSIN GASKET & MFG. CO.
Granville, Wis.

Gaskets, Fiber

THE ALLPAX COMPANY, INC.
160 Jefferson Avenue
Mamaroneck, New York

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

F. D. FARNAM CO.
4940 W. Flournoy St.
Chicago 44, Ill.

UNITED PACKING & GASKET ENGINEERING CORPORATION
5111 W. Ogden Ave.
Cicero 50, Illinois

WISCONSIN GASKET & MFG. CO.
Granville, Wis.

Gaskets, Flange

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

F. D. FARNAM CO.
4940 W. Flournoy St.
Chicago 44, Ill.

Gaskets, High Compression Internal Combustion Engines, All Metal Laminated

VICTOR MANUFACTURING & GASKET CO.
5750 Roosevelt Rd.
Chicago 50, Ill.

Gaskets, Hose

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

Gaskets, Hydraulic

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

ALBERT TROSTEL PACKINGS, LTD.
Lake Geneva, Wisconsin

Gaskets, Leather & Rawhide

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

F. D. FARNAM CO.
4940 W. Flournoy St.
Chicago 44, Ill.

ALBERT TROSTEL PACKINGS LTD.
Lake Geneva, Wisconsin

Gaskets, Metallic

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

Gaskets, Oil & Water

THE ALLPAX COMPANY, INC.
160 Jefferson Avenue
Mamaroneck, New York

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

F. D. FARNAM CO.
4940 W. Flournoy St.
Chicago 44, Ill.

THE FITZGERALD MFG. CO.
Torrington, Conn.

UNITED PACKING & GASKET ENGINEERING CORPORATION
5111 W. Ogden Ave.
Cicero 50, Illinois

VICTOR MANUFACTURING & GASKET CO.
5750 Roosevelt Rd.
Chicago 50, Ill.

Gaskets, Pipe Joint

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

Gaskets, Spiral Wound

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

Gauges. Also see Indicators; Meters

Gauges

THE ELECTRIC AUTO-LITE CO.
Champlain
Toledo 1, Ohio

ILLINOIS TESTING LABS., INC.
420 N. La Salle
Chicago 10, Ill.

Gauges, Alarm

ILLINOIS TESTING LABS., INC.
420 N. La Salle
Chicago 10, Ill.

Gauges, Draft, Portable Indicating

THE MERIAM INSTRUMENT CO.
10920 Madison Avenue
Cleveland 2, Ohio

Gauges, Fuel Oil Storage, for Stationary Storage Tanks

THE TOKHEIM COMPANY
1115 "C" Ave. NW
Cedar Rapids, Iowa

Gauges, Liquid Level

LIQUIDOMETER CORP.
41-03 36th St.
Long Island City 1, N.Y.

Gauges, Liquid Level, for Stationary Storage Tanks

LIQUIDOMETER CORP.
41-03 36th St.
Long Island City 1, N.Y.

THE MERIAM INSTRUMENTS CO.
10920 Madison Avenue
Cleveland 2, Ohio

THE TOKHEIM COMPANY
1115 "C" Ave. NW
Cedar Rapids, Iowa

Gauges, Oil Pressure

BRYCE BERGER LIMITED
Ironbarks Works
The Causeway
Staines, Middlesex, England

Gauges, Pressure

KENT-MOORE ORG., INC.
28635 Mound Road
Warren, Michigan

Gauges, Recording

THE ELECTRIC AUTO-LITE CO.
Champlain
Toledo 1, Ohio

LIQUIDOMETER CORP.
41-03 36th ST.
Long Island City 1, N.Y.

Gauges, Tank, for Stationary Storage Tanks

LIQUIDOMETER CORP.
41-03 36th St.
Long Island City 1, N.Y.

THE MERIAM INSTRUMENT CO.
10920 Madison Avenue
Cleveland 2, Ohio

THE TOKHEIM COMPANY
1115 "C" Ave. NW
Cedar Rapids, Iowa

Gauges, Water Level, for Reservoirs & Stationary Storage Tanks

THE TOKHEIM COMPANY
1115 "C" Ave. NW
Cedar Rapids, Iowa

Gauges, Whistle

SCULLY SIGNAL COMPANY
174 Green Street
Melrose 76, Mass.

Gearmotors

DELCO PRODUCTS DIV., GMC
329 E. First St.
Dayton 1, Ohio

ELLIOTT COMPANY,
Jeannette, Penna.

Gear Drives—see Drives, Gear

Gear Lubricants—see Lubricants, Gear

Geared Transmissions—see Transmissions, Geared; Transmissions, Auxiliary, Geared

Gears, Aircraft Quality

BRAD FOOTE GEAR WORKS, INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

Gears, Cut

BRAD FOOTE GEAR WORKS. INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

Gears, Ground or Shaved

BRAD FOOTE GEAR WORKS, INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

Gears, Heat-Treated

BRAD FOOTE GEAR WORKS, INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

Gears, Helical

BRAD FOOTE GEAR WORKS, INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

Gears, Internal

BRAD FOOTE GEAR WORKS, INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

Gears, Planetary

BRAD FOOTE GEAR WORKS, INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

Gears, Reduction—see Reducers, Speed

Gears, Reduction & Reverse, Marine

THE AUTO ENGINE WORKS, INC.
349 N. Hamline
St. Paul 4, Minn.

BRAD FOOTE GEAR WORKS, INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

DE LAVAL STEAM TURBINE CO.
Trenton 2, N. J.

LUFKIN FOUNDRY & MACHINE CO.
Box 58
Lufkin, Texas

THE SNOW-NABSTEDT GEAR CORP.
251 Welton St.
Hamden 7, Conn.

TWIN DISC CLUTCH COMPANY
Racine, Wis.

WESTERN GEAR WORKS
P. O. Box 182
Lynwood, Calif.

Gears, Ring, Flywheel, Starter, Etc.

BRAD FOOTE GEAR WORKS, INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

WESTERN GEAR WORKS
P. O. Box 182
Lynwood, Calif.

Gears, Speed Increaser

BRAD FOOTE GEAR WORKS, INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

DE LAVAL STEAM TURBINE CO.
Trenton 2, N. J.

LUFKIN FOUNDRY & MACHINE CO.
Box 58
Lufkin, Texas

THE SNOW-NABSTEDT GEAR CORP.
251 Welton St.
Hamden 7, Conn.

WESTERN GEAR WORKS
P. O. Box 182
Lynwood, Calif.

Gears, Spiral Bevel

BRAD FOOTE GEAR WORKS, INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

Gears, Spur

BRAD FOOTE GEAR WORKS, INC.
1309 Cicero Ave.
Cicero 50, Ill.

Gears, Worm

DE LAVAL STEAM TURBINE CO.
Trenton 2, N. J.

Gears & Pinions

BRAD FOOTE GEAR WORKS, INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

CLARK EQUIPMENT COMPANY
P. O. Box 31
Buchanan, Mich.

Gears & Pinions, Bevel

BRAD FOOTE GEAR WORKS, INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

Gears & Pinions, Herringbone

THE AUTO ENGINE WORKS INC.
349 N. Hamline
St. Paul 4, Minn.

BRAD FOOTE GEAR WORKS, INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

LUFKIN FOUNDRY & MACHINE CO.
Box 58
Lufkin, Texas

Gears & Pinions, Non-Metallic

BRAD FOOTE GEAR WORKS, INC.
1309 S. Cicero Ave.
Cicero 50, Ill.

Generating Sets, Diesel

SULZER BROS. LTD., NEW YORK
50 Church St.
New York 7, N.Y.

Generator Drives, Roller Chain Type—see Drives, Generator, Roller Chain Type

Generator Sets

BROWN BOVERI CORPORATION
19 Rector St.
New York 6, N.Y.

Generator Sets, Automatic

BALDWIN-LIMA-HAMILTON CORP.
545 North 3rd St.
Hamilton, Ohio

CONSOLIDATED DIESEL ELECTRIC CORPORATION
880 Canal St.
Stamford, Conn.

DAVEY, PAXMAN & CO. LTD.
Colchester,
Essex, England

ELECTRO-MOTIVE DIVISION
General Motors Corp.
La Grange, Ill.

ENTERPRISE ENGINE & MACHINERY CO.
18th & Florida Sts.
San Francisco 10, Calif.

FAIRBANKS, MORSE & CO.
600 So. Michigan Ave.
Chicago 5, Ill.

GRIFFIN EQUIPMENT CORP.
880 E. 141st Street
New York 54, N.Y.

LISTER-BLACKSTONE, INC.
42-32 21st Street
Long Island 1, N.Y.

NATIONAL METAL & STEEL CORP., DIESEL DIVISION
1251 New Dock Street
Terminal Island, Calif.

NORDBERG MANUFACTURING COMPANY
3073 South Chase Avenue
Milwaukee 1, Wis.

D. W. ONAN & SONS INC.
2515 University Ave. S. E.
Minneapolis 14, Minn.

THE READY-POWER CO.
11231 Freud Avenue
Detroit 14, Mich.

R. H. SHEPPARD COMPANY, INC.
Hanover, Pa.

WHITE DIESEL ENGINE DIV.
The White Motor Co.
1401 Sheridan Ave.
Springfield, Ohio

WITTE ENGINE WORKS
Oil Well Supply Division
U. S. Steel Corporation
1600 Oakland Ave.
Kansas City 26, Mo.

WORTHINGTON CORPORATION
Worthington Avenue
Harrison, N. J.

Generator Sets, Diesel, Emergency

AMERICAN MARC, INC.
1601 W. Florence Avenue
Inglewood, California

BRUSH ABOE INC.
60-07 39th Ave.
Woodside 77, Long Island, N.Y.

BUDA DIVISION
Allis-Chalmers Mfg. Co.
1135 S. 70th St.
Milwaukee 1, Wisconsin

CLEVELAND DIESEL ENGINE DIV.
General Motors Corp.
2160 West 106 Street
Cleveland 11, Ohio

CONSOLIDATED DIESEL ELECTRIC CORPORATION
880 Canal St.
Stamford, Conn.

COOPER-BESSEMER CORP.
Mount Vernon, Ohio

CUMMINS ENGINE COMPANY, INC.
Columbus, Indiana

DAVEY, PAXMAN & CO. LTD.
Colchester,
Essex, England

DETROIT DIESEL ENGINE DIVISION
General Motors Corp.
13400 W. Outer Dr.
Detroit 28, Mich.

ELECTRO-MOTIVE DIVISION
General Motors Corp.
La Grange, Ill.

FAIRBANKS, MORSE & CO.
600 So. Michigan Ave.
Chicago 5, Illinois

GRIFFIN EQUIPMENT CORP.
880 E. 141st Street
New York 54, N.Y.

P & H DIESEL ENGINE DIV.
HARNISCHFEGER CORP.
500 South Main Street
Crystal Lake, Illinois

LISTER-BLACKSTONE, INC.
42-32 21st Street
Long Island 1, N. Y.

NATIONAL METAL & STEEL CORP., DIESEL DIVISION
1251 New Dock Street
Terminal Island, Calif.

NORDBERG MANUFACTURING COMPANY
3073 South Chase Avenue
Milwaukee 1, Wis.

THE READY-POWER CO.
11231 Freud Avenue
Detroit 14, Mich.

R. H. SHEPPARD COMPANY, INC.
Hanover, Pa.

STEWART & STEVENSON SERVICES, INC.
4516 Harrisburg Blvd.
Houston 11, Texas

VENN-SEVERIN ENGINE WORKS INC.
12822 Simms Ave.
Hawthorne, Calif.

WHITE DIESEL ENGINE DIV.
The White Motor Co.
1401 Sheridan Ave.
Springfield, Ohio

WITTE ENGINE WORKS
Oil Well Supply Division
U. S. Steel Corporation
1600 Oakland Ave.
Kansas City 26, Mo.

Generator Sets, Diesel, Portable

ALCO PRODUCTS, INC.
P. O. Box 1065
Schenectady 1, N.Y.

AMERICAN MARC, INC.
1601 W. Florence Avenue
Inglewood, California

BUDA DIVISION
Allis-Chalmers Mfg. Co.
1135 S. 70th St.
Milwaukee 1, Wisconsin

CANADIAN CAR & FOUNDRY COMPANY, LTD.
621 Craig St. West
Montreal, Quebec, Canada

CONSOLIDATED DIESEL ELECTRIC CORPORATION
880 Canal St.
Stamford, Conn.

CUMMINS ENGINE COMPANY, INC.
Columbus, Indiana

ELECTRO-MOTIVE DIVISION
General Motors Corp.
La Grange, Ill.

ENTERPRISE ENGINE & MACHINERY CO.
18th & Florida Sts.
San Francisco 10, Calif.

FAIRBANKS, MORSE & CO.
600 So. Michigan Ave.
Chicago 5, Illinois

GRIFFIN EQUIPMENT CORP.
880 E. 141st Street
New York 54, N.Y.

P & H DIESEL ENGINE DIV.
HARNISCHFEGER CORP.
500 South Main Street
Crystal Lake, Illinois

LISTER-BLACKSTONE, INC.
42-32 21st Street
Long Island 1, N.Y.

D. NAPIER AND SON LTD.
Acton Vale
London, England

NORDBERG MANUFACTURING COMPANY
3073 South Chase Avenue
Milwaukee 1, Wis.

D. W. ONAN & SONS INC.
2515 University Ave. S. E.
Minneapolis 14, Minn.

THE READY-POWER CO.
11231 Freud Avenue
Detroit 14, Mich.

STEWART & STEVENSON SERVICES, INC.
4516 Harrisburg Blvd.
Houston 11, Texas

WAUKESHA MOTOR CO.
Waukesha, Wisc.

WITTE ENGINE WORKS
Oil Well Supply Division
U. S. Steel Corporation
1600 Oakland Ave.
Kansas City 26, Mo.

Generator Sets, Railway

DAVEY, PAXMAN & CO. LTD.
Colchester,
Essex, England

ELECTRO-MOTIVE DIVISION
General Motors Corp.
La Grange, Ill.

NORDBERG MANUFACTURING COMPANY
3073 South Chase Avenue
Milwaukee 1, Wis.

THE READY-POWER CO.
11231 Freud Avenue
Detroit 14, Mich.

WITTE ENGINE WORKS
Oil Well Supply Division
U. S. Steel Corporation
1600 Oakland Ave.
Kansas City 26, Mo.

Generators, Alternating Current

COLUMBIA ELECTRIC MFG. CO.
4557 Hamilton Ave.
Cleveland 14, Ohio

DELCO PRODUCTS DIV., GMC
329 E. First Street
Dayton 1, Ohio

ELECTRIC MACHINERY MFG. COMPANY
800 Central Avenue
Minneapolis 13, Minn.

ELECTRO-MOTIVE DIVISION
General Motors Corp.
La Grange, Ill.

ELLIOTT COMPANY
Jeannette, Pa.

IDEAL ELECTRIC & MFG. CO.
330 East First Street
Mansfield, Ohio

D. W. ONAN & SONS INC.
2515 University Ave. S. E.
Minneapolis 14, Minn.

Generators, Charging

AMERICAN BOSCH DIVISION
American Bosch Arma Corporation
3664 Main Street
Springfield 7, Mass.

Generators, Direct Current

COLUMBIA ELECTRIC MFG. CO.
4557 Hamilton Ave.
Cleveland 14, Ohio

DELCO PRODUCTS DIV., GMC
329 E. First Street
Dayton 1, Ohio

ELECTRO-MOTIVE DIVISION
General Motors Corp.
La Grange, Ill.

ELLIOTT COMPANY
Jeannette, Pa.

IDEAL ELECTRIC & MFG. CO.
330 East First Street
Mansfield, Ohio

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Staines, Middlesex, England

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Elmira, New York

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AiResearch Industrial Div.
9225 Aviation Blvd.
Los Angeles 45, Calif.

ROSS HEAT EXCHANGER DIV.
of American-Standard
1407 West Ave.
Buffalo 13, N.Y.

YOUNG RADIATOR COMPANY
709 S. Marquette Street
Racine, Wis.

Iron Plating—see Plating, Iron

Isolators, Vibration—see Vibration Dampeners, Absorbers, Isolators

Joints, Expansion, Corrugated Type

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

ATLANTIC METAL HOSE CO., INC.
323 Dyckman St.
New York 34, N.Y.

FLEXONICS CORPORATION
1325 S. Third Ave.
Maywood, Illinois

ZALLEA BROTHERS
830 Locust St.
Wilmington 99, Del.

Joints, Flexible, for Air, Steam, Water, Oil, etc.

THE AMERICAN BRASS COMPANY
American Metal Hose Branch
698 South Main Street
Waterbury 20, Conn.

Laboratories, Inspection & Tests

ORE RESEARCH AND LABORATORIES, INC.
1511 Levee Street
Dallas 7, Texas

Lapping Blocks

KENT-MOORE ORG., INC.
28635 Mound Road
Warren, Michigan

Lathes, Brake Drum

VAN NORMAN AUTOMOTIVE EQUIPMENT COMPANY
3640 Main St.
Springfield 7, Mass.

Lathes, Single Spindle, Hand & Automatic

GISHOLT MACHINE COMPANY
1251 E. Washington Ave.
Madison 10, Wis.

Lathes, Turret, Hand and Automatic

GISHOLT MACHINE COMPANY
1251 E. Washington Ave.
Madison 10, Wisconsin

Lighting Plants, Emergency

CONSOLIDATED DIESEL ELECTRIC CORPORATION
880 Canal St.
Stamford, Conn.

D. W. ONAN & SONS INC.
2515 University Ave. S. E.
Minneapolis 14, Minn.

THE READY-POWER CO.
11231 Freud Avenue
Detroit 14, Mich.

R. H. SHEPPARD COMPANY, INC.
Hanover, Pa.

Liner Plating, Porous Chrome—see Plating, Porous Chrome and Liners, Cylinder, Porous Chrome Reclaiming

Liners, Cylinder

DAROS AMERICAN CORP.
8128 No. Lawndale
Skokie, Ill.

EXLINE ENGINE WORKS
Box 446
Salina, Kansas

NICKLES MACHINE CORPORATION
600 South First Street
Ponca City, Okla.

GEORGE W. STETSON, JR.
141 Milk Street
Boston 9, Mass.

Liners, Cylinder, Chrome Plating

SPAR-TAN ENGINEERING CO.
(Western Licensee—Van der Horst Corporation)
496 Bauchet Street
Los Angeles 12, California
758 Seventh Street
Oakland 7, California

Liners, Cylinder, Cracks Repaired

BRODIE SYSTEM
115 Clifton Place
Brooklyn 38, N.Y.

EXLINE ENGINE WORKS
Box 446
Salina, Kansas

Liners, Cylinder, Porous Chrome Reclaiming

PENNINGTON CHANNEL-CROMIUM COMPANY
319 Dakota St.
San Antonio 3, Texas

SPAR-TAN ENGINEERING CO.
(Western Licensee—Van der Horst Corporation)
496 Bauchet Street
Los Angeles 12, California
758 Seventh Street
Oakland 7, California

VAN DER HORST CORP.
Olean, N.Y. and
Terrell, Tex., Chicago, Ill.
Los Angeles, Calif.

Liners, Cylinder, Reclaimed

EXLINE ENGINE WORKS
Box 446
Salina, Kansas

Lines, Flexible Metal, Compressed Air

THE AMERICAN BRASS COMPANY
American Metal Hose Branch
698 South Main Street
Waterbury 20, Conn.

ATLANTIC METAL HOSE CO., INC.
323 Dyckman St.
New York 34, N.Y.

Lines, Flexible Metal, Fresh & Salt Water

ATLANTIC METAL HOSE CO., INC.
323 Dyckman St.
New York 34, N.Y.

Lines, Flexible Metal, Lubricating Oil

THE AMERICAN BRASS COMPANY
American Metal Hose Branch
698 South Main Street
Waterbury 20, Conn.

ATLANTIC METAL HOSE CO., INC.
323 Dyckman St.
New York 34, N.Y.

Lines, Hose, Flexible

ANCHOR COUPLING CO., INC.
342 N. Fourth St.
Libertyville, Ill.

Liquid Honing Machines—see Honing Machines, Liquid

Liquid Level Gauges—see Gauges, Liquid Level

Liquid Level Indicators—see Indicators, Liquid Level

Loaders, Tractor Mounted

CLARK EQUIPMENT COMPANY
P.O. Box 31
Buchanan, Michigan

Lock Nuts

COLUMBIA NUT & BOLT CO.
945 Main St.
Bridgeport 3, Conn.

STANDARD PRESSED STEEL CO.
Box 397
Jenkintown, Pa.

Locomotives, Diesel

ALCO PRODUCTS, INC.
P.O. Box 1065
Schenectady 1, N.Y.

ELECTRO-MOTIVE DIVISION
General Motors Corp.
La Grange, Ill.

Locomotives, Mine, Diesel–see Diesel Mine Locomotives

Lubricants, Automotive

SINCLAIR REFINING CO.
600 Fifth Ave.
New York 20, N.Y.

THE CALIFORNIA
OIL COMPANY
1200 State St.
Perth Amboy, N.J.

VALVOLINE OIL COMPANY
Div. of Ashland Oil & Refining Co.
Freedom, Penna.

Lubricants, Diesel Engine

SINCLAIR REFINING CO.
600 Fifth Ave.
New York 20, N.Y.

THE CALIFORNIA OIL
COMPANY
1200 State St.
Perth Amboy, N.J.

VALVOLINE OIL COMPANY
Div. of Ashland Oil & Refining Co.
Freedom, Penna.

Lubricants, Gear

SINCLAIR REFINING CO.
600 Fifth Ave.
New York 20, N.Y.

VALVOLINE OIL COMPANY
Div. of Ashland Oil & Refining Co.
Freedom, Penna.

Lubricants, Heavy Duty

E. H. KELLOGG & CO., INC.
63-East First St.
Mount Vernon, N.Y.

SINCLAIR REFINING CO.
600 Fifth Ave.
New York 20, N.Y.

THE CALIFORNIA
OIL COMPANY
1200 State St.
Perth Amboy, N.J.

Lubricating Oil–see Oil, Lubricating

Lubricating Oil Coolers–see Coolers, Lubricating Oil

Lubricating Oil Filters–see Filters, Lubricating Oil

Lubricating Oil Purifiers–see Purifiers, Lubricating Oil

Lubricating Systems

ROBERT BOSCH CORPORATION
268 Fourth Avenue
New York 10, N.Y.

MANZEL DIV. of
Houdaille Industries Inc.
315 Babcock St.
Buffalo 10, New York

WM. W. NUGENT & CO., INC.
3441 Cleveland St.
Skokie, Ill.

STEWART-WARNER
CORPORATION
1826 Diversey Parkway
Chicago 14, Illinois

Lubricators, Fresh Oil

MANZEL DIV. of
Houdaille Industries Inc.
315 Babcock St.
Buffalo 10, New York

Lubricators, Forced Feed, Mechanical

MANZEL DIV. of
Houdaille Industries Inc.
315 Babcock St.
Buffalo 10, New York

Lubricators, Locomotive–see Lubricators, Sight Feed

Lubricators, Machinery, High Pressure

MANZEL DIV. of
Houdaille Industries Inc.
315 Babcock St.
Buffalo 10, New York

Lubricators, Mechanical–see Lubricators, Force Feed

Lubricators, Multiple Oiling

MANZEL DIV. of
Houdaille Industries Inc.
315 Babcock St.
Buffalo 10, New York

WM. W. NUGENT & CO., INC.
3441 Cleveland St.
Skokie, Ill.

Lubricators, Sight Feed

MANZEL DIV. of
Houdaille Industries Inc.
315 Babcock St.
Buffalo 10, New York

WM. W. NUGENT & CO., INC.
3441 Cleveland St.
Skokie, Ill.

Lubricators, for Timed Lubrication

MANZEL DIV. of
Houdaille Industries Inc.
315 Babcock St.
Buffalo 10, New York

Machine Bases–see Bases & Frames, Machine

Machine Tools, Precision Honing–see Honing Machine Tools, Precision

Machine Work, Precision

HARTFORD MACHINE
SCREW CO.
Box 1440
Hartford 2, Conn.

Machine Work to Order

HARTFORD MACHINE
SCREW CO.
Box 1440
Hartford 2, Conn.

Machinery Isolation–see Vibration Dampeners, Absorbers, Isolators

Machine Tools, Metal Turning

JOHN S. BARNES CORP.
301 South Water St.
Rockford, Illinois

GISHOLT MACHINE COMPANY
1251 E. Washington Ave.
Madison 10, Wisconsin

Machines, Super-Finishing

GISHOLT MACHINE COMPANY
1251 E. Washington Ave.
Madison 10, Wis.

Machinists, Contracting–see Machine Work to Order

Magnetos, High Tension

AMERICAN BOSCH DIVISION
American Bosch Arma Corporation
3664 Main Street
Springfield 7, Mass.

SCINTILLA DIVISION
Bendix Aviation Corp.
Delaware Avenue
Sidney, N.Y.

Magnetos, Low Tension

AMERICAN BOSCH DIVISION
American Bosch Arma Corporation
3664 Main Street
Springfield 7, Mass.

SCINTILLA DIVISION
Bendix Aviation Corp.
Delaware Avenue
Sidney, N.Y.

Main Bearing Nuts–see Nuts, Main Bearing

Manifolds, Exhaust, Welded

THE DAYTON FABRICATED
STEEL COMPANY
1300 E. Monument Avenue
Dayton 3, Ohio

STOVER STEEL TANK & MFG.
CO.
101 S. Hancock Ave.
Freeport, Ill.

Manifolds, Multiple Outlet

FLUOR PRODUCTS COMPANY
DIV. OF FLUOR CORP., LTD.
12000 E. Washington Blvd.
Whittier, California

Manometers

THE MERIAM INSTRUMENT CO.
10920 Madison Avenue
Cleveland 2, Ohio

Marine Auxiliary Sets–see Auxiliary Units, Marine

Marine Diesel Engines–see Engines, Diesel, Marine

Marine Electrical Controls–see Controls, Electrical, Marine

Marine Propeller Reconditioning–see Propeller Reconditioning, Marine

Marine Propulsion

ALCO PRODUCTS, INC.
P.O. Box 1065
Schenectady 1, N.Y.

CLEVELAND DIESEL
ENGINE DIV.
General Motors Corp.
2160 West 106 Street
Cleveland 11, Ohio

DE LAVAL STEAM TURBINE CO.
Trenton 2, N. J.

DIESEL ENERGY CORPORATION
82 Beaver St.
New York 5, N.Y.

GRAY MARINE MOTOR CO.
710 Canton Ave.
Detroit 7, Michigan

NATIONAL METAL & STEEL
CORP., DIESEL DIVISION
1251 New Dock Street
Terminal Island, Calif.

NORDBERG MANUFACTURING
COMPANY
3073 South Chase Avenue
Milwaukee 1, Wis.

F. PERKINS LIMITED
Peterborough, England

R. H. SHEPPARD COMPANY, INC.
Hanover, Pa.

Marine Propulsion Engines

HERCULES MOTORS
CORPORATION
101 Eleventh S.E.
Canton 2, Ohio

Marine Reduction Gears–see Gears, Reduction & Reverse, Marine

Marine Reverse & Reduction Transmissions–see Transmissions, Marine

Megohmmeters

JAMES G. BIDDLE CO.
1316 Arch Street
Phila. 7, Pa.

Metal Finishing–see Electroplating

Metal Spraying

GUTH COMPANY
400-412 North Chestnut
McPherson, Kansas

Metal Spraying, Repairs

BRODIE SYSTEM
115 Clifton Place
Bklyn. 38, N.Y.

Meters, Air Velocity

ILLINOIS TESTING LABS, INC.
420 N. LaSalle
Chicago 10, Ill.

Meter Calibrating Tanks–see Tanks, Meter Calibrating

Meters, Frequency, Vibrating Reed Type

JAMES G. BIDDLE CO.
1316 Arch Street
Phila. 7, Pa.

Meters, Flow

THE MERIAM INSTRUMENT CO.
10920 Madison Avenue
Cleveland 2, Ohio

Meters, Gas

ROOTS-CONNERSVILLE BLOWER
900 West Mount Street
Connersville, Ind.

Meters, Smoke

Motor Controls—see Controls, Electric Motor

Motor Drives—see Drives (Specific type)

Motor Fuels—see Fuels, Motor

Motor Generators—see Generators, Motor

Motor Oils—see Oil, Motor

Motors, Air, Diesel Starting

INGERSOLL-RAND CO.
11 Broadway
New York 4, N.Y.

Motors, Air, Starting

INGERSOLL-RAND CO.
11 Broadway
New York 4, N.Y.

Motors, Cranking, Air

INGERSOLL-RAND CO.
11 Broadway
New York 4, N.Y.

Motors, Cranking, Electric

THE ELECTRIC AUTO-LITE CO.
Champlain
Toledo 1, Ohio

Motors, Diesel Engine Starting

ROBERT BOSCH CORPORATION
268 Fourth Avenue
New York 10, N.Y.

C.A.V. FUEL INJECTION EQUIPMENT
Division of Lucas Electrical Services, Inc.
14820 Detroit Avenue
Cleveland 7, Ohio

THE ELECTRIC AUTO-LITE CO.
Champlain
Toledo 1, Ohio

INGERSOLL-RAND CO.
11 Broadway
New York 4, N.Y.

START PILOT CO., INC.
61 Second Street
Mineola, N.Y.

Motors, Electric, A.C.

DELCO PRODUCTS DIV., GMC
329 E. First Street
Dayton 1, Ohio

ELECTRIC MACHINERY MFG. COMPANY
800 Central Avenue
Minneapolis 13, Minn.

ELLIOTT COMPANY
Jeannette, Pa.

IDEAL ELECTRIC & MFG. CO.
330 East First Street
Mansfield, Ohio

Motors, Electric, D.C.

THE ELECTRIC AUTO-LITE CO.
Champlain
Toledo 1, Ohio

ELECTRO-MOTIVE DIVISION
General Motors Corp.
La Grange, Ill.

ELLIOTT COMPANY
Jeannette, Pa.

IDEAL ELECTRIC & MFG. CO.
330 East First Street
Mansfield, Ohio

PESCO PRODUCTS DIVISION
Borg-Warner Corporation
24700 North Miles Road
Bedford, Ohio

Motors, Fractional Horsepower

DELCO PRODUCTS DIV., GMC
329 E. First Street
Dayton 1, Ohio

Motors, Gear—see Gearmotors

Motors, Hydraulic

JOHN S. BARNES CORP.
301 South Water St.
Rockford, Illinois

DE LAVAL STEAM TURBINE CO.
Trenton 2, N. J.

PESCO PRODUCTS DIVISION
Borg-Warner Corporation
24700 North Miles Road
Bedford, Ohio

Motors, Starting, Electric

C.A.V. FUEL INJECTION EQUIPMENT
Division of Lucas Electrical Services, Inc.
14820 Detroit Avenue
Cleveland 7, Ohio

THE ELECTRIC AUTO-LITE CO.
Champlain
Toledo 1, Ohio

Mountings, Resilient—see Vibration Dampeners, Absorbers, Isolators

Mufflers, Exhaust

BURGESS-MANNING COMPANY
742 E. Park Ave.
Libertyville, Ill.

DONALDSON COMPANY, INC.
666 Pelham Blvd.
St. Paul 14, Minn.

FLUOR PRODUCTS COMPANY
DIV. OF FLUOR CORP., LTD.
12000 E. Washington Blvd.
Whittier, California

KITTELL MUFFLER & ENGR'G, INC.
915 S. Santa Fe
Los Angeles 21, Calif.

THE MAXIM SILENCER COMPANY
85 Homestead Ave.
Hartford 1, Conn.

Mufflers, Intake & Exhaust

BURGESS-MANNING COMPANY
742 E. Park Ave.
Libertyville, Ill.

DONALDSON COMPANY, INC.
666 Pelham Blvd.
St. Paul 14, Minn.

FLUOR PRODUCTS COMPANY
DIV. OF FLUOR CORP., LTD.
12000 E. Washington Blvd.
Whittier, California

KITTELL MUFFLER & ENGR'G, INC.
915 S. Santa Fe
Los Angeles 21, Calif.

THE MAXIM SILENCER COMPANY
85 Homestead Ave.
Hartford 1, Conn.

Mufflers, Internal Combustion Engine

BURGESS-MANNING COMPANY
742 E. Park Ave.
Libertyville, Ill.

DONALDSON COMPANY, INC.
666 Pelham Blvd.
St. Paul 14, Minn.

FLUOR PRODUCTS COMPANY
DIV. OF FLUOR CORP., LTD.
12000 E. Washington Blvd.
Whittier, California

HARCO MANUFACTURING CO.
2041 S.W. 58th
Portland 1, Ore.

KITTELL MUFFLER & ENGR'G, INC.
915 S. Santa Fe
Los Angeles 21, Calif.

THE MAXIM SILENCER COMPANY
85 Homestead Ave.
Hartford 1, Conn.

Mufflers, Spark Arresting

BURGESS-MANNING COMPANY
742 E. Park Ave.
Libertyville, Ill.

FLUOR PRODUCTS COMPANY
DIV. OF FLUOR CORP., LTD.
12000 E. Washington Blvd.
Whittier, California

KITTELL MUFFLER & ENGR'G, INC.
915 S. Santa Fe
Los Angeles 21, Calif.

THE MAXIM SILENCER COMPANY
85 Homestead Ave.
Hartford 1, Conn.

Nameplates, Etched, Engraved, Cast, Stamped & Embossed

THE ELECTRIC AUTO-LITE CO.
Champlain
Toledo 1, Ohio

Nozzle Holders, Fuel Injection

ADECO PRODUCTS, INC.
5435 No. Wolcott Ave.
Chicago 40, Illinois

AMERICAN BOSCH DIVISION
American Bosch Arma Corporation
3664 Main Street
Springfield 7, Mass.

ROBERT BOSCH CORPORATION
268 Fourth Avenue
New York 10, N.Y.

BRYCE BERGER LIMITED
Ironbarks Works
The Causeway
Staines, Middlesex, England

C.A.V. FUEL INJECTION EQUIPMENT
Division of Lucas Electrical Services, Inc.
14820 Detroit Avenue
Cleveland 7, Ohio

SCINTILLA DIVISION
Bendix Aviation Corp.
Delaware Avenue
Sidney, N.Y.

Nozzle Tester—see Testers, Nozzle

Nozzles, for Cooling Towers & Spray Ponds

SPRAYING SYSTEMS COMPANY
3201 Randolph Street
Bellwood, Ill.

Nozzles, Diesel, Cleaning & Repairs

ENGINEERING DEVELOPMENT CORPORATION
1009 East Pike
Seattle 22, Wash.

Nozzles, Fuel Injection

ADECO PRODUCTS, INC.
5435 No. Wolcott Ave.
Chicago 40, Illinois

AMERICAN BOSCH DIVISION
American Bosch Arma Corporation
3664 Main Street
Springfield 7, Mass.

BRYCE BERGER LIMITED
Ironbarks Works
The Causeway
Staines, Middlesex, England

ROBERT BOSCH CORPORATION
268 Fourth Avenue
New York 10, N.Y.

C.A.V. FUEL INJECTION EQUIPMENT
Division of Lucas Electrical Services, Inc.
14820 Detroit Avenue
Cleveland 7, Ohio

MICRO PRECISION DIV.
of Micromatic Hone Corp.
2205 Lee St.
Evanston, Ill.

SCINTILLA DIVISION
Bendix Aviation Corp.
Delaware Avenue
Sidney, N.Y.

Nozzles, Spray, Fuel Injection

AMERICAN BOSCH DIVISION
American Bosch Arma Corporation
3664 Main Street
Springfield 7, Mass.

BRYCE BERGER LIMITED
Ironbarks Works
The Causeway
Staines, Middlesex, England

SCINTILLA DIVISION
Bendix Aviation Corp.
Delaware Avenue
Sidney, N.Y.

Nozzles, Spray, Water

CHAIN BELT COMPANY
4701 W. Greenfield Ave.
Milwaukee 1, Wis.

FLUOR PRODUCTS COMPANY
DIV. OF FLUOR CORP., LTD.
12000 E. Washington Blvd.
Whittier, California

THE MARLEY COMPANY
222 W. Gregory
Kansas City 14, Missouri

SCOVILL MANUFACTURING COMPANY
99 Mill Street
Waterbury 20, Conn.

SPRAYING SYSTEMS COMPANY
3201 Randolph Street
Bellwood, Ill.

Nuts, Cap

INDUSTRIAL NUT CORP.
1425 Tiffin Ave.
Sandusky, Ohio

Nuts, Castellated & Slotted—see Nuts, General

Nuts, Check and Jam

ERIE BOLT & NUT CO.
1325 Liberty
Erie, Pennsylvania

INDUSTRIAL NUT CORP.
1425 Tiffin Ave.
Sandusky, Ohio

Nuts, Cylinder Head

ERIE BOLT & NUT CO.
1325 Liberty
Erie, Pa.

INDUSTRIAL NUT CORP.
1425 Tiffin Ave.
Sandusky, Ohio

Nuts, General

COLUMBIA NUT & BOLT CO.
945 Main St.
Bridgeport 3, Conn.

ERIE BOLT & NUT CO.
1325 Liberty
Erie, Pa.

INDUSTRIAL NUT CORP.
1425 Tiffin Ave.
Sandusky, Ohio

Nuts, Lock—see Lock Nuts

Nuts, Main Bearing

ERIE BOLT & NUT CO.
1325 Liberty
Erie, Pa.

INDUSTRIAL NUT CORP.
1425 Tiffin Ave.
Sandusky, Ohio

Nuts, Self-Retaining

COLUMBIA NUT & BOLT CO.
945 Main St.
Bridgeport 3, Conn.

INDUSTRIAL NUT CORP.
1425 Tiffin Ave.
Sandusky, Ohio

Nuts, Semi-Finished

ERIE BOLT & NUT CO.
1325 Liberty
Erie, Pa.

INDUSTRIAL NUT CORP.
1425 Tiffin Ave.
Sandusky, Ohio

Nuts, Super-Finished, Special

COLUMBIA NUT & BOLT CO.
945 Main St.
Bridgeport 3, Conn.

ERIE BOLT & NUT CO.
1325 Liberty
Erie, Fa.

INDUSTRIAL NUT CORP.
1425 Tiffin Ave.
Sandusky, Ohio

Oil, Analysis Spectrographic

ORE RESEARCH AND LABORATORIES, INC.
1511 Levee Street
Dallas 7, Texas

"O" Rings—see Packing, O & V Ring; also Rings, "O"

Oil Clarifiers—see Clarifiers

Oil Conditioners—see Conditioners, Oil

Oil Coolers—see Coolers, Oil

Oil, Cutting

SINCLAIR REFINING CO.
600 Fifth Ave.
New York 20, N.Y.

Oil, Diesel Fuel

ASHLAND OIL & REFINING CO.
1409 Winchester Ave.
Ashland, Ky.

SINCLAIR REFINING CO.
600 Fifth Ave.
New York 20, N.Y.

Oil, Diesel Fuel, Water Separators —see Separators, Water, Diesel Fuel

Oil Field Utility Units—see Utility Units, Oil Field

Oil Filter Elements, Lube—see Filter Elements, Lube Oil

Oil Filters—see Filters, Oil

Oil & Grease, Lubricating

ASHLAND OIL & REFINING CO.
1409 Winchester Ave.
Ashland, Ky.

E. H. KELLOGG & CO., INC.
63-East First St.
Mount Vernon, N.Y.

VALVOLINE OIL COMPANY
Div. of Ashland Oil & Refining Co.
Freedom, Penna.

Oil Heaters—see Heaters, Oil

Oil, Hydraulic

SINCLAIR REFINING CO.
600 Fifth Ave.
New York 20, N.Y.

Oil, Industrial

ASHLAND OIL & REFINING CO.
1409 Winchester Ave.
Ashland, Ky.

SINCLAIR REFINING CO.
600 Fifth Ave.
New York 20, N.Y.

STANDARD OIL COMPANY OF CALIFORNIA
225 Bush Street
San Francisco 20, Calif.

Oil, Lubricating, Automotive

SINCLAIR REFINING CO.
600 Fifth Ave.
New York 20, N.Y.

Oil, Lubricating, Diesel

SINCLAIR REFINING CO.
600 Fifth Ave.
New York 20, N.Y.

STANDARD OIL COMPANY OF CALIFORNIA
225 Bush Street
San Francisco 20, Calif.

Oil, Lubricating, Industrial

E. H. KELLOGG & CO., INC.
63-East First St.
Mount Vernon, N.Y.

SINCLAIR REFINING CO.
600 Fifth Ave.
New York 20, N.Y.

Oil, Motor

STANDARD OIL COMPANY OF CALIFORNIA
225 Bush Street
San Francisco 20, Calif.

Oil Pumps—see Pumps, Oil

Oil Purification Systems, Pressure & Gravity

HOFFMAN-ALLEN CORPORATION
P.O. Box 626
Springfield, Missouri

Oil Purifiers—see Purifiers, Oil

Oil Reclamation Systems

HOFFMAN-ALLEN CORPORATION
P.O. Box 626
Springfield, Missouri

Oil Refiners

HOFFMAN-ALLEN CORPORATION
P.O. Box 626
Springfield, Missouri

Oil Seals—see Seals, Oil, Grease or Dust

Oil Strainers—see Strainers, Oil

Packing, Acid & Chemical Resisting

THE ALLPAX COMPANY, INC.
160 Jefferson Avenue
Mamaroneck, N.Y.

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

C. LEE COOK COMPANY
916 South 8th St.
Louisville 3, Ky.

Packing, Asbestos, Compressed

THE ALLPAX COMPANY, INC.
160 Jefferson Avenue
Mamaroneck, N.Y.

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

F. D. FARNAM CO.
4940 W. Flournoy St.
Chicago 44, Ill.

Packing, Braided, Hydraulic

THE ALLPAX COMPANY, INC.
160 Jefferson Avenue
Mamaroneck, N.Y.

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

Packing, Hydraulic, High Pressure

THE ALLPAX COMPANY, INC.
160 Jefferson Avenue
Mamaroneck, New York

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

Packing, Hydraulic & Pneumatic

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

ALBERT TROSTEL PACKINGS, LTD.
Lake Geneva, Wisconsin

Packing, Lead, Shredded

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

Packing, Leather

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

ALBERT TROSTEL PACKINGS, LTD.
Lake Geneva, Wisconsin

Packing, Metallic

THE ALLPAX COMPANY, INC.
160 Jefferson Avenue
Mamaroneck, N.Y.

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

C. LEE COOK COMPANY
916 South 8th St.
Louisville 3, Ky.

Packing, O & V Ring

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

ALBERT TROSTEL PACKINGS, LTD.
Lake Geneva, Wisconsin

VICTOR MANUFACTURING & GASKET CO.
5750 Roosevelt Rd.
Chicago 50, Ill.

Packing, Oil Resistant

THE ALLPAX COMPANY, INC.
160 Jefferson Avenue
Mamaroneck, N.Y.

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

ALBERT TROSTEL PACKINGS, LTD.
Lake Geneva, Wisconsin

Packing, Oil Wiper

DOUBLE SEAL RING CO.
2065 Montgomery St.
Fort Worth, Texas

ALBERT TROSTEL PACKINGS, LTD.
Lake Geneva, Wisconsin

Packing, Piston Rod

THE ALLPAX COMPANY, INC.
160 Jefferson Avenue
Mamaroneck, New York

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

C. LEE COOK COMPANY
916 South 8th St.
Louisville 3, Ky.

DOUBLE SEAL RING CO.
2065 Montgomery St.
Fort Worth, Texas

ALBERT TROSTEL PACKINGS, LTD.
Lake Geneva, Wisconsin

Packing, Plastic

THE ALLPAX COMPANY, INC.
160 Jefferson Avenue
Mamaroneck, N.Y.

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

Packing, Rod

THE ALLPAX COMPANY, INC.
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Louisville 3, Ky.

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Mamaroneck, New York

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C. LEE COOK COMPANY
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Louisville 3, Ky.

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Fort Worth, Texas

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Philadelphia 8, Pa.

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Packing, Sheet, for Oil & Water

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Cleveland 10, Ohio

NICKLES MACHINE CORPORATION
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Ponca City, Okla.

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STANDARD PRESSED STEEL CO.
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Jenkintown, Pa.

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Schenectady 1, N.Y.

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Whittier, California

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Freeport, Ill.

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Milwaukee 16, Wis.

Piston Heads & Skirts Repaired by Welding

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Piston Rings—see Rings, Piston

Piston Rod Packing—see Packing, Piston Rod

Piston Rods—see Connecting Rods

Piston Sealing Rings—see Rings, Piston, Sealing

Pistons

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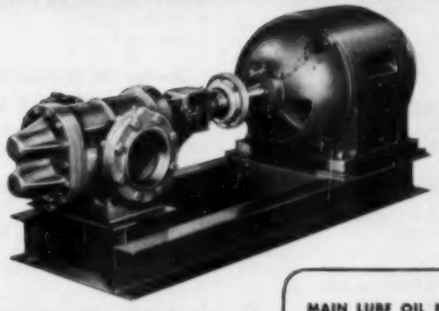

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Richmond 1, Calif.

UNITED ELECTRIC CONTROLS CO.
85 School St.
Watertown 72, Mass.

Regulators, Temperature, Cooling Water

ROBERTSHAW-FULTON CONTROLS CO.
Fulton Sylphon Div.
P. O. Box 400
Knoxville 1, Tenn.

UNITED ELECTRIC CONTROLS CO.
85 School St.
Watertown 72, Mass.

Regulators, Temperature, Lube Oil

ROBERTSHAW-FULTON CONTROLS CO.,
Fulton Sylphon Div.
P. O. Box 400
Knoxville 1, Tenn.

UNITED ELECTRIC CONTROLS CO.
85 School St.
Watertown 72, Mass.

Regulators, Voltage

AMERICAN BOSCH DIVISION
American Bosch Arma Corporation
3664 Main Street
Springfield 7, Mass.

THE ELECTRIC AUTO-LITE CO.
Champlain
Toledo 1, Ohio

Relays

AUTOMATIC SWITCH COMPANY
50-56 Hanover Road
Florham Park, N. J.

LAKE SHORE ELECTRIC CORP.
205 Willis St.
Bedford, Ohio

Relays, Alarm & Signal

ILLINOIS TESTING LABS., INC.
420 N. LaSalle
Chicago 10, Ill.

VAPOR HEATING CORPORATION
80 E. Jackson
Chicago 4, Ill.

Relays, Industrial Control

TECHNIFLEX MFG. CO., INC.
55 Jersey Ave.
Port Jervis, N.Y.

Relief Valves—see Valves, Relief

Remote Controls, Transmission—see Controls, Remote, Transmission

Removers, Paint, Enamel & Varnish, Liquid

BRULIN & COMPANY, INC.
2939-45 Columbia Avenue
Indianapolis 7, Indiana

OAKITE PRODUCTS, INC.
22E Rector St.
New York 6, N.Y.

TURCO PRODUCTS, INC.
6135 S. Central Ave.
Los Angeles 1, Calif.

Repair Stands, Engine

CLAYBORNE MANUFACTURING COMPANY
429 North Main St.
Monticello, Ind.

Resilient Mountings—see Vibration Dampeners, Absorbers, Isolators

Retainers, Grease & Oil
Also see Seals, Oil, Grease or Dust

ALBERT TROSTEL PACKINGS, LTD.
Lake Geneva, Wisconsin

Ring, Piston, Expander for Removing & Replacing Rings

DOUBLE SEAL RING CO.
2065 Montgomery St.
Fort Worth, Texas

EXLINE ENGINE WORKS
Box 446
Salina, Kansas

K-D MANUFACTURING COMPANY
526 North Plum St.
Lancaster, Pa.

Ring, Piston, Installation Tools

EXLINE ENGINE WORKS
Box 446
Salina, Kansas

K-D MANUFACTURING COMPANY
526 North Plum St.
Lancaster, Pa.

WILKENING MFG. CO.
2000 S. 71st St.
Philadelphia 42, Pa.

Rings, "O"

THE ANCHOR PACKING CO.
401 N. Broad St.
Philadelphia 8, Pa.

ALBERT TROSTEL PACKINGS, LTD.
Lake Geneva, Wisconsin

UNITED AIRCRAFT PRODUCTS, INC.
1116 Bolander Ave.
Dayton 1, Ohio

VICTOR MANUFACTURING & GASKET CO.
5750 Roosevelt Rd.
Chicago 50, Ill.

Rings, Piston

C. LEE COOK COMPANY
916 South 8th St.
Louisville 3, Ky.

DAROS AMERICAN CORP.
8128 No. Lawndale
Skokie, Ill.

DOUBLE SEAL RING CO.
2065 Montgomery St.
Fort Worth, Texas

KOPPERS COMPANY, INC.
Metal Products Division
200 Scott Street
Baltimore 3, Md.

PERFECT CIRCLE CORPORATION
552 S. Washington St.
Hagerstown, Ind.

WILKENING MFG. CO.
2000 S. 71st St.
Philadelphia 42, Pa.

Rings, Piston, Oil Control

C. LEE COOK COMPANY
916 South 8th St.
Louisville 3, Ky.

DAROS AMERICAN CORP.
8128 No. Lawndale
Skokie, Ill.

DOUBLE SEAL RING CO.
2065 Montgomery St.
Fort Worth, Texas

KOPPERS COMPANY, INC.
Metal Products Division
200 Scott Street
Baltimore 3, Md.

PERFECT CIRCLE CORPORATION
552 S. Washington St.
Hagerstown, Ind.

WILKENING MFG. CO.
2000 S. 71st St.
Philadelphia 42, Pa.

Rings, Piston, Sealing

C. LEE COOK COMPANY
916 South 8th St.
Louisville 3, Ky.

DAROS AMERICAN CORP.
8128 No. Lawndale
Skokie, Ill.

DOUBLE SEAL RING CO.
2065 Montgomery St.
Fort Worth, Texas

KOPPERS COMPANY, INC.
Metal Products Division
200 Scott Street
Baltimore 3, Md.

PERFECT CIRCLE CORPORATION
552 S. Washington St.
Hagerstown, Ind.

WILKENING MFG. CO.
2000 S. 71st St.
Philadelphia 42, Pa.

Rings, Sealing

C. LEE COOK COMPANY
916 South 8th St.
Louisville 3, Ky.

DAROS AMERICAN CORP.
8128 No. Lawndale
Skokie, Ill.

DOUBLE SEAL RING CO.
2065 Montgomery St.
Fort Worth, Texas

KOPPERS COMPANY, INC.
Metal Products Division
200 Scott Street
Baltimore 3, Md.

PERFECT CIRCLE CORPORATION
552 S. Washington St.
Hagerstown, Ind.

WILKENING MFG. CO.
2000 S. 71st St.
Philadelphia 42, Pa.

Rings, Sealing, Bronze

C. LEE COOK COMPANY
916 South 8th St.
Louisville 3, Ky.

DOUBLE SEAL RING CO.
2065 Montgomery St.
Fort Worth, Texas

KOPPERS COMPANY, INC.
Metal Products Division
200 Scott Street
Baltimore 3, Md.

Rings, Welded

DRESSER MANUFACTURING DIVISION
41 Fisher Avenue
Bradford, Pa.

Rings, Wearing, Piston Groove–see Piston Groove Wearing Rings

Rod Ends

SOUTHWEST PRODUCTS CO.
1705 So. Mountain Ave.
Duarte, Calif.

Rods, Connecting–see Connecting Rods

Rods, Piston–see Connecting Rods

Roller Bearings–see Bearings, Roller

Roller Chains–see Chains, Roller

Rotary Pumps–see Pumps, Rotary

Rubber Bearings–see Bearings, Oil-less; also Bearings, Self-Lubricating

Rust Inhibitor, Cooling System

D. W. HAERING & CO., INC.
Box 6037, Harl. Station
San Antonio 4, Texas

THE PEROLIN COMPANY, INC.
350 Fifth Avenue
New York 1, N.Y.

Rust Remover Compounds

D. W. HAERING & CO., INC.
Box 6037, Harl. Station
San Antonio 4, Texas

OAKITE PRODUCTS, INC.
22E Rector St.
New York 6, N.Y.

Rust Resistant Compounds–see Compounds, Rust Resistant

Safety Control, Diesel Engine

AMOT CONTROLS CORPORATION
P. O. Box 1707
Richmond 1, Calif.

CUSTOM BUILT CONTROLS, INC.
661 Delaware St.
Denver 4, Colo.

PENN CONTROLS, INC.
Goshen, Ind.

Scale Removing Compounds–see Compounds, Scale Removing

Scavenging Air & Supercharging Blower Drives–see Drives, Scavenging Air & Supercharging Blower

Scavenging Air Blowers & Superchargers–see Blowers & Superchargers, Scavenging

Schools, Diesel Engineering

F. PERKINS LIMITED
Peterborough, England

Schools, Tractor & Diesel

F. PERKINS LIMITED
Peterborough, England

Screw Machine Products to Order

THE CHICAGO SCREW CO.
2701 Washington Blvd.
Bellwood, Ill.

COLUMBIA NUT & BOLT CO.
945 Main St.
Bridgeport 3, Conn.

HARTFORD MACHINE SCREW CO.
Box 1440
Hartford 2, Conn.

SCOVILL MANUFACTURING COMPANY
99 Mill Street
Waterbury 20, Conn.

Screw Machine Products Precision Hardened & Ground

THE CHICAGO SCREW CO.
2701 Washington Blvd.
Bellwood, Ill.

HARTFORD MACHINE SCREW CO.
Box 1440
Hartford 2, Conn.

Screws, Set, Socket, Cap; Hex

THE CHICAGO SCREW CO.
2701 Washington Blvd.
Bellwood, Ill.

Screws, Set, Socket, Cap; Hex & Spline

THE BRISTOL COMPANY
P. O. Box 1790 DEC
Waterbury 20, Conn.

HARTFORD MACHINE SCREW CO.
Box 1440
Hartford 2, Conn.

STANDARD PRESSED STEEL CO.
Box 397
Jenkintown, Pa.

Scrubbers, Gas

FLUOR PRODUCTS COMPANY DIV. OF FLUOR CORP., LTD.
12000 E. Washington Blvd.
Whittier, California

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Seals, Automatic Shaft

SCHWITZER CORPORATION
1125 Massachusetts Ave.
Indianapolis 7, Indiana

Seals, Mechanical

CLEVELAND GRAPHITE BRONZE CO.
Division of Clevite Corporation
17000 St. Clair Avenue
Cleveland 10, Ohio

KOPPERS COMPANY, INC.
Metal Products Division
200 Scott Street
Baltimore 3, Md.

ALBERT TROSTEL PACKINGS, LTD.
Lake Geneva, Wisconsin

Seals, Oil, Grease or Dust

THE FITZGERALD MFG. CO.
Torrington, Conn.

ALBERT TROSTEL PACKINGS, LTD.
Lake Geneva, Wisconsin

VICTOR MANUFACTURING & GASKET CO.
5750 Roosevelt Rd.
Chicago 50, Ill.

Seals, Pump Shaft

SCHWITZER CORPORATION
1125 Massachusetts Ave.
Indianapolis 7, Indiana

ALBERT TROSTEL PACKINGS, LTD.
Lake Geneva, Wisconsin

VICTOR MANUFACTURING & GASKET CO.
5750 Roosevelt Rd.
Chicago 50, Ill.

Seals, Rotary

ROBERTSHAW-FULTON CONTROLS CO.
Fulton Sylphon Divn.
P. O. Box 400
Knoxville 1, Tenn.

ALBERT TROSTEL PACKINGS, LTD.
Lake Geneva, Wisconsin

Self-Locking Nuts—see Lock Nuts

Self-Retaining Nuts—see Nuts, Self-Retaining

Separators

CENTRICO INC.
75 W. Forest Ave.
Englewood, N. J.

THE DE LAVAL SEPARATOR CO.
The De Laval Building
Poughkeepsie, N.Y.

ENGINEERING CONTROLS, INC.
818 Olive Street
St. Louis 1, Mo.

Separators, Water & Contaminants—Fuel Oil

THE BRIGGS FILTRATION COMPANY
Dept. 152
River Road
Washington 16, D. C.

CENTRICO INC.
75 W. Forest Ave.
Englewood, N. J.

THE DE LAVAL SEPARATOR CO.
The De Laval Building
Poughkeepsie, N.Y.

FRAM CORPORATION
Providence 16, R. I.

WM. W. NUGENT & CO., INC.
3441 Cleveland St.
Skokie, Ill.

Separators, Water, Diesel Fuel

THE BRIGGS FILTRATION COMPANY
Dept. 152
River Road
Washington 16, D. C.

CENTRICO INC.
75 W. Forest Ave.
Englewood, N. J.

THE DE LAVAL SEPARATOR CO.
The De Laval Building
Poughkeepsie, N.Y.

WM. W. NUGENT & CO., INC.
3441 Cleveland St.
Skokie, Ill.

Separators, Water-Oil

CENTRICO INC.
75 W. Forest Ave.
Englewood, N. J.

THE DE LAVAL SEPARATOR CO.
The De Laval Building
Poughkeepsie, N.Y.

HONAN CRANE DIVISION
Commercial Filters Corp.
415 Indianapolis Ave.
Lebanon, Ind.

WM. W. NUGENT & CO. INC.
3441 Cleveland St.
Skokie, Ill.

Shafting, Flexible—see Flexible Shafts & Equipment

Shafting, Turned & Ground

MUSKEGON CAMSHAFT CO.
1747 Seventh St.
Muskegon, Mich.

Shafts, Cam—see Camshafts

Shafts, Compressor

MUSKEGON CAMSHAFT CO.
1747 Seventh St.
Muskegon, Mich.

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Shafts, Hardened & Ground

THE CHICAGO SCREW CO.
2701 Washington Blvd.
Bellwood, Ill.

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Tenth Street
Ellwood City, Penna.

HARTFORD MACHINE SCREW CO.
Box 1440
Hartford 2, Conn.

MUSKEGON CAMSHAFT CO.
1747 Seventh St.
Muskegon, Mich.

Shafts, Steel, Carbon Alloy

ALCO PRODUCTS, INC.
P. O. Box 1065
Schenectady 1, N.Y.

ELLWOOD CITY FORGE COMPANY
Tenth Street
Ellwood City, Penna.

ERIE FORGE & STEEL CORP.
Erie, Pennsylvania

Shutters, Radiator, Automatic

KYSOR HEATER COMPANY
1100 W. Wright St.
Cadillac, Michigan

Shims

WISCONSIN GASKET & MFG. CO.
Granville, Wisconsin

Silencers, Exhaust—see Mufflers, Internal Combustion Engine

Silencers, Intake

BURGESS-MANNING COMPANY
749 E. Park Ave.
Libertyville, Ill.

FLUOR PRODUCTS COMPANY
DIV. OF FLUOR CORP., LTD.
12000 E. Washington Blvd.
Whittier, California

KITTELL MUFFLER & ENGR'G, INC.
915 S. Santa Fe
Los Angeles 21, Calif.

THE MAXIM SILENCER COMPANY
85 Homstead Ave.
Hartford 1, Conn.

Silencers, Spark Arresting

BURGESS-MANNING COMPANY
749 E. Park Ave.
Libertyville, Ill.

FLUOR PRODUCTS COMPANY
DIV. OF FLUOR CORP., LTD.
12000 E. Washington Blvd.
Whittier, California

KITTELL MUFFLER & ENGR'G, INC.
915 S. Santa Fe
Los Angeles 21, Calif.

THE MAXIM SILENCER COMPANY
85 Homestead Ave.
Hartford 1, Conn.

Sleeve Cylinder, Assemblies

DURA-BOND ENGINE PARTS CO.
715 Loma Verde Avenue
Palo Alto, California

Sleeves, Cylinder

DURA-BOND ENGINE PARTS CO.
715 Loma Verde Avenue
Palo Alto, California

EXLINE ENGINE WORKS
Box 446
Salina, Kansas

PENNINGTON CHANNELCROMIUM COMPANY
319 Dakota St.
San Antonio 3, Texas

Sludge Removing Compounds—see Compounds, Sludge Removing

Snubbers, Combination Intake Cleaner Silencer

BURGESS-MANNING COMPANY
749 E. Park Ave.
Libertyville, Ill.

Snubbers, Exhaust & Intake

BURGESS-MANNING COMPANY
749 E. Park Ave.
Libertyville, Ill.

Solenoid Valves—see Valves, Solenoid Operated

Solenoids

JOHN S. BARNES CORP.
301 South Water St.
Rockford, Illinois

AUTOMATIC SWITCH COMPANY
50-56 Hanover Road
Florham Park, N. J.

Solvents

ASHLAND OIL & REFINING CO.
1409 Winchester Ave.
Ashland, Ky.

CURRAN CORPORATION
South Canal Street
Lawrence, Mass.

STANDARD OIL COMPANY OF CALIFORNIA
225 Bush Street
San Francisco 20, Calif.

Solvents, Degreasing

BRULIN & COMPANY, INC.
2939-45 Columbia Avenue
Indianapolis 7, Ind.

CLAYTON MANUFACTURING COMPANY
401 North Temple City Blvd.
El Monte, Calif.

CURRAN CORPORATION
South Canal Street
Lawrence, Mass.

OAKITE PRODUCTS, INC.
22E Rector St.
New York 6, N.Y.

THE PEROLIN COMPANY, INC.
350 Fifth Avenue
New York 1, N.Y.

PETROLEUM SOLVENTS CORPORATION
331 Madison Ave.
New York 17, N.Y.

SINCLAIR REFINING CO.
600 Fifth Ave.
New York 20, N.Y.

Sound Absorbing Materials—see Felt, Acoustic

Spark Arresters—see Arresters, Spark

Spark Ignition Engines—see Engines, Spark Ignition

Speed Changers, Variable—see Transmission, Adjustable Speed; Drives, Adjustable Speed

Speed Increasers—see Increasers, Speed

Speed Indicators—See Indicators, Speed

Speed Reducers—see Reducers, Speed

Speed Regulators—see Regulators, Speed

Spray Nozzles—see Nozzles, Spray

Spring Testers—see Testers, Spring

Sprocket Chains—see Chains, Drive

Sprockets

CHAIN BELT COMPANY
4701 W. Greenfield Ave.
Milwaukee 1, Wis.

DIAMOND CHAIN COMPANY, INC.
402 Kentucky Ave.
Indianapolis 7, Ind.

MORSE CHAIN COMPANY
Ithaca, N.Y.

Stands, Test—see Test Stands

Starters, Diesel, Hydraulic

BRYCE BERGER LIMITED
Ironbarks Works
The Causeway
Staines, Middlesex, England

DETROIT DIESEL ENGINE DIVISION
General Motors Corp.
13400 W. Outer Dr.
Detroit 28, Mich.

SINCLAIR REFINING CO.
600 Fifth Ave.
New York 20, N.Y.

Starting Air Compressors—see Compressors, Air, Starting

Starting Engines—see Engines, Starting

Starting Fluid

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600 Fifth Ave.
New York 20, N.Y.

STANDARD OIL COMPANY OF CALIFORNIA
225 Bush Street
San Francisco 20, Calif.

START PILOT CO., INC.
61 Second St.
Mineola, N.Y.

WILCO COMPANY
4425 Bandini Boulevard
Los Angeles 23, Calif.

Starting Fluid, Capsules, Metal

THE CALIFORNIA OIL COMPANY
1200 State St.
Perth Amboy, N. J.

Starting Fluid, 11-oz. Pressurized Container

WILCO COMPANY
4425 Bandini Boulevard
Los Angeles 23, Calif.

Starting Fluid, Sprayer

WILCO COMPANY
4425 Bandini Boulevard
Los Angeles 23, Calif.

Starting Fuels

START PILOT CO., INC.
61 Second St.
Mineola, N.Y.

Starting Motors—see Motors, Starting

Starting Storage Batteries—see Batteries, Storage, Starting

Starting Switches—see Switches, Starting

Steam Cleaners—see Cleaners, Steam

Steam Cleaning Compounds—see Compounds, Steam Cleaning

Steam Cleaning Equipment

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401 North Temple City Blvd.
El Monte, Calif.

OAKITE PRODUCTS, INC.
22E Rector St.
New York 6, N.Y.

TURCO PRODUCTS, INC.
6135 S. Central Ave.
Los Angeles 1, Calif.

Steel Camshaft Repair—see Camshafts, Steel, Repair

Steel Castings—see Castings, Steel

Steel Ingots & Billets

ERIE FORGE & STEEL CORP.
Erie, Pennsylvania

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Strainers, Fuel

THE HILLIARD CORPORATION
122 W. 4th St.
Elmira, New York

BLACKMER PUMP COMPANY
1809 Century Avenue, S.W.
Grand Rapids 9, Michigan

WM. W. NUGENT & CO., INC.
3441 Cleveland St.
Skokie, Ill.

WINSLOW ENGINEERING COMPANY
4069 Hollis Street
Oakland, Calif.

Strainers, Light Fuel Oil

THE HILLIARD CORPORATION
122 W. 4th St.
Elmira, New York

WM. W. NUGENT & CO., INC.
3441 Cleveland St.
Skokie, Ill.

Strainers, Oil, Twin & Single

ELLIOTT COMPANY
Jeannette, Pa.

THE HILLIARD CORPORATION
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Elmira, New York

WINSLOW ENGINEERING COMPANY
4069 Hollis Street
Oakland, Calif.

Strainers, Pipe Line

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3441 Cleveland St.
Skokie, Ill.

SPRAYING SYSTEMS COMPANY
3201 Randolph Street
Bellwood, Ill.

Strainers, Water

WM. W. NUGENT & CO., INC.
3441 Cleveland St.
Skokie, Ill.

SPRAYING SYSTEMS COMPANY
3201 Randolph Street
Bellwood, Ill.

Strainers, Water, Single & Duplex

ELLIOTT COMPANY
Jeannette, Pa.

Studs, Alloy & Stainless Steel

ERIE BOLT & NUT CO.
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Erie, Pa.

Studs, Carbon

ERIE BOLT & NUT CO.
1325 Liberty
Erie, Pa.

Studs, Cylinder

ERIE BOLT & NUT CO.
1325 Liberty
Erie, Pa.

Studs, Diesel Engine

ERIE BOLT & NUT CO.
1325 Liberty
Erie, Pa.

Studs, Ground Thread

ERIE BOLT & NUT CO.
1325 Liberty
Erie, Pa.

Studs, Steel

ERIE BOLT & NUT CO.
1325 Liberty
Erie, Pa.

STANDARD PRESSED STEEL CO.
Box 397
Jenkintown, Pa.

Supercharger Intercoolers—see Intercoolers, Supercharger

Superchargers, Turbo-superchargers

ALCO PRODUCTS, INC.
P. O. Box 1065
Schenectady 1, N.Y.

BROWN BOVERI CORPORATION
19 Rector St.
New York 6, N.Y.

DE LAVAL STEAM TURBINE CO.
Trenton 2, N. J.

ELLIOTT COMPANY
Jeannette, Pa.

THE GARRETT CORPORATION
AiResearch Industrial Div.
9225 Aviation Blvd.
Los Angeles 45, Calif.

SIR GEORGE GODFREY & PARTNERS (INDUSTRIAL) LTD.
Hampton Road West
Hanworth, Middx., England

MIEHLE-DEXTER SUPERCHARGER
100 Fourth Street
Racine, Wis.

WADE ENGINEERING LTD.
Crowhurst Road
Brighton 6, Sussex, England

Supercharging Blowers—see Blowers, Supercharger

Superfinishers, Crankshaft

GISHOLT MACHINE COMPANY
1251 E. Washington Ave.
Madison 10, Wis.

Switchboards & Instruments

IDEAL ELECTRIC & MFG. CO.
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Mansfield, Ohio

Switches, Electric

UNITED ELECTRIC CONTROLS CO.
85 School St.
Watertown 72, Mass.

Switches, Engine Safety

AMOT CONTROLS CORPORATION
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Richmond 1, Calif.

CUSTOM BUILT CONTROLS, INC.
661 Delaware St.
Denver 4, Colo.

Switches, Flow Alarm

THE MERIAM INSTRUMENT CO.
10920 Madison Avenue
Cleveland 2, Ohio

Switches, Pushbutton

THE ELECTRIC AUTO-LITE CO.
Champlain
Toledo 1, Ohio

Switches, Solenoid

THE ELECTRIC AUTO-LITE CO.
Champlain
Toledo 1, Ohio

Switches, Starting, Electric

C.A.V. FUEL INJECTION EQUIPMENT
Division of Lucas Electrical Services, Inc.
14820 Detroit Avenue
Cleveland 7, Ohio

Switches, Temperature Control

ILLINOIS TESTING LABS., INC.
420 N. La Salle
Chicago 10, Ill.

UNITED ELECTRIC CONTROLS CO.
85 School St.
Watertown 72, Mass.

Switches, Transfer, Automatic

AUTOMATIC SWITCH COMPANY
50-56 Hanover Road
Florham Park, N. J.

LAKE SHORE ELECTRIC CORP.
205 Willis St.
Bedford, Ohio

UNITED ELECTRIC CONTROLS CO.
85 School St.
Watertown 72, Mass.

Switchgear Equipment

ELECTRIC MACHINERY MFG. COMPANY
800 Central Avenue
Minneapolis 13, Minn.

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205 Willis St.
Bedford, Ohio

Synchronizers, Automatic

ELECTRIC MACHINERY MFG. COMPANY
800 Central Avenue
Minneapolis 13, Minn.

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21 Park Row
New York 38, N.Y.

Tachometers

JAMES G. BIDDLE CO.
1316 Arch Street
Phila. 7, Pa.

THE BRISTOL COMPANY
P. O. Box 1790 DEC
Waterbury 20, Conn.

THE ELECTRIC AUTO-LITE CO.
Champlain
Toledo 1, Ohio

THE ELECTRO-MECHANO CO.
261 E. Erie St.
Milwaukee 2, Wis.

KENT-MOORE ORG., INC.
28635 Mound Road
Warren, Michigan

STEWART-WARNER CORPORATION
1826 Diversey Parkway
Chicago 14, Illinois

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1316 Arch Street
Phila. 7, Pa.

O. ZERNICKOW CO.
21 Park Row
New York 38, N.Y.

Tachometers, Chronometric

JAMES G. BIDDLE CO.
1316 Arch Street
Phila. 7, Pa.

O. ZERNICKOW CO.
21 Park Row
New York 38, N.Y.

Tachometers, Diesel Engine

THE ELECTRO-MECHANO CO.
261 E. Erie St.
Milwaukee 2, Wis.

Tachometers, Electrical

THE ELECTRO-MECHANO CO.
261 E. Erie St.
Milwaukee 2, Wis.

Tachometers, Hand

JAMES G. BIDDLE CO.
1316 Arch Street
Phila. 7, Pa.

THE ELECTRO-MECHANO CO.
261 E. Erie St.
Milwaukee 2, Wis.

O. ZERNICKOW CO.
21 Park Row
New York 38, N.Y.

Tachometers, Hand, Resonant Reed Type

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Phila. 7, Pa.

Tachometers, Mechanical

JAMES G. BIDDLE CO.
1316 Arch Street
Phila. 7, Pa.

Tachometers, Resonant Reed

JAMES G. BIDDLE CO.
1316 Arch Street
Phila. 7, Pa.

Tanks, Alloy & Special Metals

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Whittier, California

Tanks, A.S.M.E.

FLOUR PRODUCTS COMPANY
DIV. OF FLUOR CORP., LTD.
12000 E. Washington Blvd.
Whittier, California

STOVER STEEL TANK & MFG. CO.
101 S. Hancock Ave.
Freeport, Ill.

Tanks, Steel

FLUOR PRODUCTS COMPANY
DIV. OF FLUOR CORP., LTD.
12000 E. Washington Blvd.
Whittier, California

STOVER STEEL TANK & MFG. CO.
101 S. Hancock Ave.
Freeport, Ill.

Tanks, Wood

FLUOR PRODUCTS COMPANY
DIV. OF FLUOR CORP., LTD.
12000 E. Washington Blvd.
Whittier, California

Tappets, Valve

THE CHICAGO SCREW CO.
2701 Washington Blvd.
Bellwood, Ill.

Temperature Controls—see Controls, Temperature

Temperature Recorders—see Recorders, Temperature

Temperature Regulators—see Regulators, Temperature

Temperature Switches—see Switches, Temperature Control

Test Pumps, Portable, Hydraulic

KIENE DIESEL ACCESSORIES, INC.
10352 Pacific Ave.
Franklin Park, Ill.

Test Stands

CLAYBORNE MANUFACTURING COMPANY
429 North Main St.
Monticello, Ind.

CONSOLIDATED DIESEL ELECTRIC CORPORATION
880 Canal St.
Stamford, Conn.

WESTERN RAILROAD SUPPLY CO.
2400-2434 S. Ashland Ave.
Chicago 8, Illinois

Test Stands, Diesel Fuel Injector

AMERICAN BOSCH DIVISION
American Bosch Arma Corporation
3664 Main Street
Springfield 7, Mass.

ROBERT BOSCH CORPORATION
268 Fourth Avenue
New York 10, N.Y.

LESLIE HARTRIDGE (CANADA) LTD.
330 Bay St.
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Thermometers, Dial

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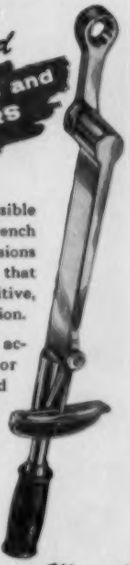

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Talks the Buyer's Language: The *readers* of DIESEL PROGRESS respect the *writers* of DIESEL PROGRESS – because they are the same breed of men. DIESEL PROGRESS maintains eight field editors in this country and one in Europe – all of them solidly experienced both in diesels and journalism. Monthly columns are contributed by America's leading diesel experts in the automotive, marine and other fields. The articles in DIESEL PROGRESS are *actual case histories* of diesel applications in use, diesel problems solved, and the latest diesel developments. DIESEL PROGRESS, while its information is detailed and factual, is not a technical journal as such. It is a reporter of diesel news and a meeting-place for the exchange of diesel information between experts, the men who know the diesel world. Generous use of photographs and diagrams coupled with brief and incisive text combine to make a wide-open, easy-to-read, format in a big 9 x 12 page size, a format that really *communicates*. Proof: Impartial surveys by a national circulation auditor shows that 91% of the readers of DIESEL PROGRESS consider as useful both editorial *and advertising* content.

NEXT DIESEL ENGINE CATALOG CLOSES APRIL 1, 1958

Annually for 22 years DIESEL PROGRESS has compiled and published the DIESEL ENGINE CATALOG regarded by the entire diesel industry as the one and only authoritative buying guide and complete reference manual for diesel engines and accessories. This 400-page, 10½" x 13½" size, industry bible is found on every desk that counts in the diesel industry. Hundreds of engines, plus the essential and rapidly advancing fields of turbochargers, transmissions, fuel injection systems, governors – all are presented in their own sections complete with photographs, power curves, specification tables, dimensional installation plans and sectional views, plus full description in the text of products, applications and conversions. In addition, approximately 100 pages of advertising from industry leaders constitute a catalog in themselves!

Do You Know Your Diesel Market?

There will be 226,150 diesel, dual fuel and gas engines produced in 1957. Diesels in use today: 2,190,000 engines, 8.3 billion gallons of diesel fuel and 465 million gallons of lubricating oil were used in 1957 – a total dollar volume of $1.7 billion.

(For more information write for complete Diesel Progress Market Data File.)

DIESEL PROGRESS

816 N. La Cienega Blvd. Los Angeles 46, Calif.
Phone: OLeander 5-7410

Write today for advertising rates and specifications, or see Standard Rate & Data.

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